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SVIC NOTES

SOFTWARE DISSEMINATION

I would like to pose a question which is of concern to many people in Government Information Centers. Is the Government competing with private industry by disseminating computer programs? I hope by the end of this note that I will answer this question and possibly illuminate some side issues.

There have been cases in the past where commercial firms have complained that the Government was competing with them and thereby were able to make the Government stop what it was doing. This same logic is now being applied by some commercial firms to prevent the dissemination of computer programs by Government Information Centers. It is obvious that the Government shouldn't be in the manufacturing business. For example, the Government shouldn't be making cars and competing with the U.S. automobile manufacturers. But disseminating computer programs isn't the same thing as making cars.

If tax dollars have been paid for the generation of a computer program, there shouldn't be any question as to the legality of supplying the information to the public. Also, if a Government Center supplies a user with a program for a fee the user should be guaranteed an error free working program with accurate documentation. However, if the users experience difficulty in getting the program running on their machine, there is a question about the amount of help that should be given by the Government supplier. The Government suppliers have an obligation to the user to make sure that any initial problems are not their fault. If the program will not load, or if the sample problems do not work, the Government supplier should give at least enough help to make sure the user has an error-free copy of the program of the correct configuration. The Government Center should be able to do this much without being accused of competing. Even here, there is room for some variation in the degree of help rendered. If the users pay premium prices they should expect on-site help from the supplier. If all the users pay is the handling and postage costs, they shouldn't expect any more than moral support and a few phone calls. You get what you pay for!

Government dissemination centers should provide no greater service. They should not act as consultants on the application of the programs to specific shock and vibration problems, since they would then be competing directly with Engineering and Software firms. In this framework there is ample room for an Information Center to "consult" with a user on a particular program deficiency. It may just be a "bug" in the program which is causing the difficulty, in which case the Center would be justified in helping. It is a matter of judgement, calling for cooperation by all parties concerned.

This is an important issue which should be resolved rationally. The Government Information Centers are here to serve the taxpayers and should be allowed to furnish information related to their mission. As we enter the last two decades of the Century we will be taxing the limits of our ability to transfer information even with computer-aided techniques.

It would be folly to cripple the available resources at this time.

J.G.S.

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EDITORS RATTLE SPACE

DYNAMIC ANALYSIS AND DESIGN

At the 50th Shock and Vibration Symposium in October, Robert Hager presented one of the plenary lectures. The subject of his thought-provoking lecture was dynamic analysis and design. The thrust of Mr. Hager's lecture was two-fold - present-day analytical capability is not being used effectively, and excessive testing is being done on hardware. Although Hager might have sounded a bit controversial on the testing matter, his comments are worth thinking about.

It is Mr. Hager's opinion that techniques for dynamic analysis are not being used effectively in the design process. I support his contention; furthermore, I believe dynamic analysis is not used enough in diagnostic-troubleshooting work. It is natural in the design process to use computer analysis to check out new concepts and developments before they are used to generate hardware. Concepts that are not feasible can thereby often be eliminated before the expenses of manufacturing and testing prototype are undertaken. In the area of diagnostic work technicians and engineers are bypassing this valuable tool – dynamic analysis – when they attempt to determine machine and structural faults from measurements alone. Analytical work based on mathematical models can be used to simulate system behavior and phenomena that caused the failure. Not only can the cause of a failure be isolated from such information, but system design improvements can also be implemented. These improvements can be incorporated -- if they are simple -- when the hardware is repaired. Often these improvements will lessen the sensitivity of the system to future failures.

I do not believe that design analysis can replace final prototype testing. Simulation of the physics of hardware is just not good enough, nor are the physical phenomena involved in the mathematical models detailed or complete enough to replace product testing. In addition, quantification of these phenomena would probably be counterproductive because more effort would be required to quantify the phenomena than to test the concept.

Finally, I want to comment on the fact that mathematical analysis is not used in design and diagnosis: those who provide techniques and services involved with mathematical analysis have not made it easy for the "lay" engineer to use. Understanding and implementation of these techniques and services often require experts. I believe that this is one of the most important reasons so little of this work is used.

R.L.E.

EIGENVALUE METHODS FOR VIBRATION ANALYSIS

A. Jennings*

Abstract - This article reviews methods for solving dynamic equations to determine characteristic response. In particular numerical methods for eigensolution are considered, as is their relationship to the analysis of both undamped and damped systems.

Because vibration analysis has been one of the main sources of numerical eigenvalue problems there is a close historical link between them [1, 2]. However, eigenvalues now are more widely used, so that there is less liaison between engineers interested in vibration and numerical analysts interested in eigensolutions. Furthermore, there are so many outlets for publication that very few are conversant with all the majoi developments. It is hoped that this paper will help to rectify this disturbing situation.

STANDARD UNDAMPED EQUATIONS

Computer methods for dynamic analysis of structures have been based mainly on displacement variables similar to those that have been used almost universally for static analysis. A member AB of a plane frame can have six node displacements allocated as shown in Figure 1a. If the member is subject to a unit displacement of variable 2 with no displacement for variables 1, 3, 4, 5, and 6 as shown in Figure 1b, then nodal forces k_{22}, k_{32}, k_{52}, and k_{62} will be needed to keep the member in static equilibrium and at the same time satisfy the bending equation. The forces k_{22}, k_{32}, k_{52}, and k_{62} are known as member stiffness coefficients; these and the other stiffness coefficients for the members of a frame can be evaluated and compounded in order to obtain the stiffness matrix $\underset{\sim}{K}$ for the complete frame.

In a dynamic analysis an inertia load is present along the length of the member (Figure 1c); hence the deflection will not be cubic. If the members are a small part of the overall structure, however, distribution of the inertia force is not critical, and it is possible to assume that the distributed mass is replaced by equivalent lumped masses at the nodes [3]. In this case a steady oscillation of variable 2 and frequency ω will give rise to an oscillating reversed inertia force with a maximum value as shown in Figure 1d. A more accurate assumption is that the inertia forces are consistent with a cubic variation of acceleration along the member [4]. It is then necessary to use the Rayleigh-Ritz principle, invoking virtual work, to obtain equivalent nodal inertia forces as shown in Figure 1e. In either case the reversed inertia forces can be considered to act on the structure, so that no external forces the dynamic equations for the frame can be specified as

$$\underset{\sim}{K}\underset{\sim}{x} = \omega^2 \underset{\sim}{M}\underset{\sim}{x} \tag{1}$$

where $\underset{\sim}{x}$ is the vector of joint (or nodal) displacements. In the case of the lumped mass idealization the mass matrix $\underset{\sim}{M}$ is diagonal with nonnegative elements; in the case of the consistent mass idealization $\underset{\sim}{M}$ is symmetric positive definite. If the frame has no body freedoms, $\underset{\sim}{K}$ will be symmetric positive definite; otherwise it will be symmetric positive semidefinite with a mode of singularity associated with each body freedom. Another possible procedure for frame analysis is to obtain the exact solution for each member so that the nodal forces can be specified as functions of the frequency (Figure 1f). In this case the dynamic equations for the frame become

$$\overline{\underset{\sim}{K}}\underset{\sim}{x} = \underset{\sim}{0} \tag{2}$$

The elements of $\overline{\underset{\sim}{K}}$ are transcendental functions of ω^2 [5, 6]. Continuum structures represented by finite elements can similarly be idealized by lumped mass or consistent mass methods [7-11], but an

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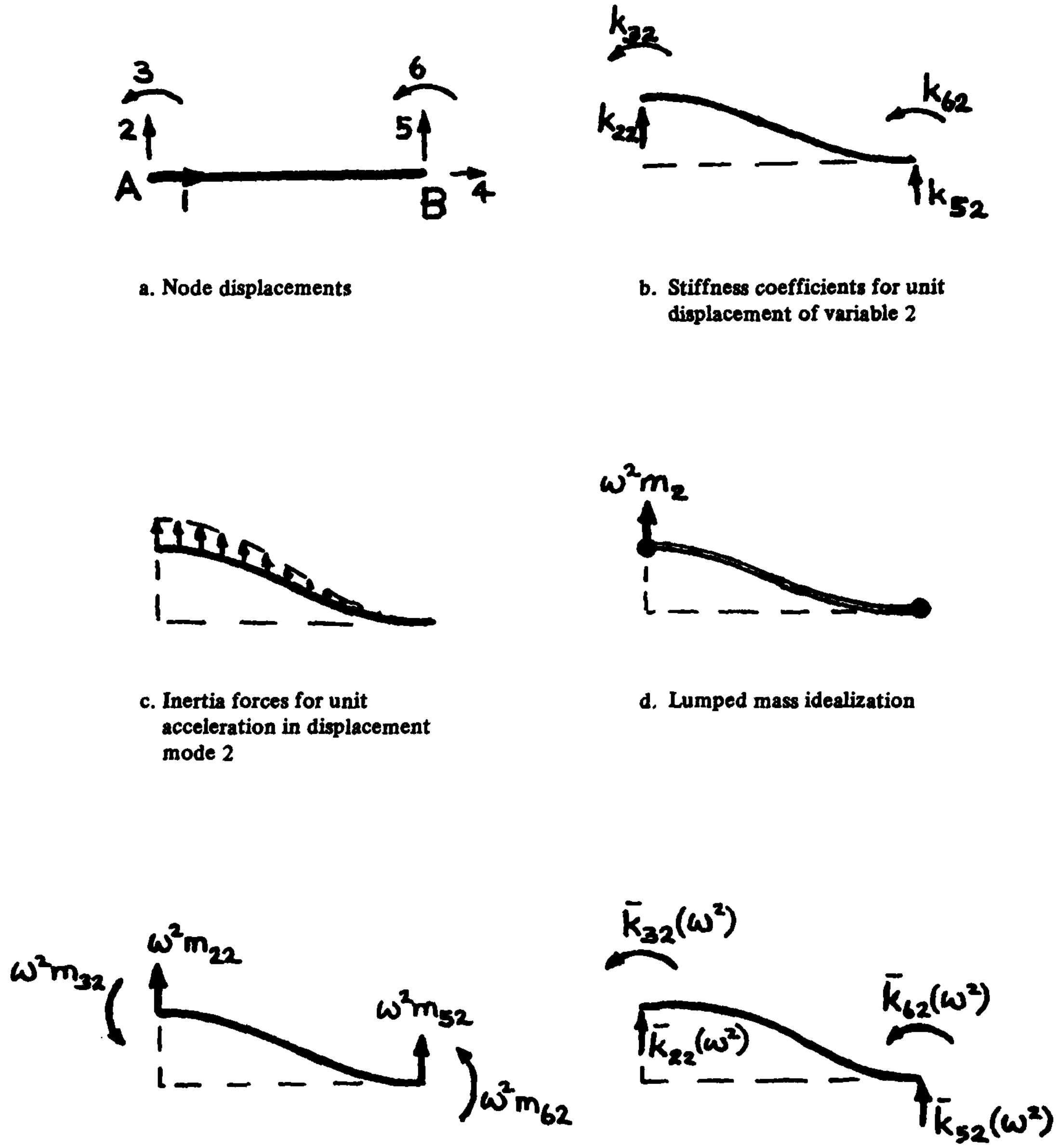

a. Node displacements

b. Stiffness coefficients for unit displacement of variable 2

c. Inertia forces for unit acceleration in displacement mode 2

d. Lumped mass idealization

e. Consistent mass idealization

f. Frequency-dependent stiffness

Figure 1. Stiffness and Mass Representation of a Member of a Plane Structural Frame

exact solution for each element cannot be obtained. The dynamic stiffness method would thus appear to be ruled out; however, see Williams and Wittrick [12]. Mass and stiffness matrices tend to be sparse and easily arranged in band form. Either the lowest frequency or a set of the lower frequencies is required. Frequencies within a prescribed interval are occasionally required. In any case computed higher frequencies will generally be inaccurate due to approximations made in the idealization.

EIGENSOLUTION CLASSIFICATIONS

The standard matrix eignevalue problem can be represented by

$$\underset{\sim}{A}\underset{\sim}{q} = \lambda \underset{\sim}{q} \tag{3}$$

Where $\underset{\sim}{A}$ is an $n \times n$ matrix, λ is an eigenvalue, and $\underset{\sim}{q}$ is the corresponding eigenvector. There must be n eigenvalues and corresponding eigenvectors; these will all be real, or real positive, when $\underset{\sim}{A}$ is symmetric, or symmetric positive definite, respectively. However if $\underset{\sim}{A}$ is unsymmetric (and real) there is the possibility that complex eigenvalues occur in conjugate pairs. Eigensolution procedures are generally more complicated for the unsymmetric eigenvalue problem; the symmetric form should therefore be employed whenever possible [13-17]. Fortunately equation (1) can usually be converted in two basic ways to a symmetric eigenvalue problem. Using either of the Choleski factorizations $\underset{\sim}{K} = \underset{\sim}{L}\underset{\sim}{L}^T$ or $\underset{\sim}{M} = \underset{\sim}{G}\underset{\sim}{G}^T$, equation (1) can be transformed to

$$(\underset{\sim}{L}^{-1}\underset{\sim}{M}\underset{\sim}{L}^{-T})(\underset{\sim}{L}^T\underset{\sim}{x}) = \frac{1}{\omega^2}(\underset{\sim}{L}^T\underset{\sim}{x}) \tag{4}$$

or

$$(\underset{\sim}{G}^{-1}\underset{\sim}{K}\underset{\sim}{G}^{-T})(\underset{\sim}{G}^T\underset{\sim}{x}) = \omega^2(\underset{\sim}{G}^T\underset{\sim}{x}) \tag{5}$$

respectively [15, 18], provided only that the matrix to be factorized is nonsingular.

The factorization of the stiffness matrix is very similar to the main process of solving a static stress problem having the same stiffness matrix. However, the matrix $\underset{\sim}{L}^{-1}\underset{\sim}{M}\underset{\sim}{L}^{-T}$ is not sparse, and its formal computation should not be attempted except for small order problems. When the lumped mass idealization has yielded a diagonal mass matrix, its factorization is a trivial operation; the transformation $\underset{\sim}{G}^{-1}\underset{\sim}{K}\underset{\sim}{G}^{-T}$ retains the sparseness of $\underset{\sim}{K}$.

More attention has been devoted in recent years to solving generalized eigenvalue problems without first transforming them to standard form [19]. The linear generalized eigenvalue problem can be represented by

$$\underset{\sim}{A}\underset{\sim}{q} = \lambda \underset{\sim}{B}\underset{\sim}{q} \tag{6}$$

The quadratic generalized eigenvalue problem can be represented by

$$(\lambda^2\underset{\sim}{A} + \lambda\underset{\sim}{B} + \underset{\sim}{C})\underset{\sim}{q} = \underset{\sim}{O} \tag{7}$$

The nonlinear generalized eigenvalue problem can be represented by

$$\underset{\sim}{A}(\lambda)\underset{\sim}{q} = \underset{\sim}{O} \tag{8}$$

Thus, without transformation of the matrices, equations (1) and (2) are linear and nonlinear generalized eigenvalue problems respectively.

Eigensolution procedures for symmetric matrices can be extended to include complex matrices that are Hermitian. Thus, numerical procedures developed for Hermitian matrix eigensolution take advantage of symmetry.

OTHER FORMS OF THE EQUATIONS

Galerkin and complementary energy methods of deriving vibration equations for undamped structures give symmetric linear generalized eigenvalue equations or the equivalent [20-25]. However, if boundary integral methods are used, unsymmetric equations with densely populated matrices are obtained [26]. A gyroscopic system gives rise to a Hermitian matrix eigenvalue problem [27]; Meirovitch has transformed the problem to standard linear generalized eigenvalue form [28, 29].

Damped structures are not conservative systems and so do not usually give rise to symmetric eigenvalue problems [30-32]. However, dynamic equations can be written to include a damping matrix $\underset{\sim}{C}$.

$$\underset{\sim}{M}\ddot{\underset{\sim}{x}} + \underset{\sim}{C}\dot{\underset{\sim}{x}} + \underset{\sim}{K}\underset{\sim}{x} = \underset{\sim}{O} \tag{9}$$

Equation (9) can be converted, using the substitutions $\underset{\sim}{q}_1 = \underset{\sim}{x}e^{\lambda t}$ and $\underset{\sim}{q}_2 = \lambda \underset{\sim}{q}_1$, to the linear general-

ized form [7, 33, 34].

$$\begin{bmatrix} \underset{\sim}{M} & \underset{\sim}{0} \\ \underset{\sim}{0} & -\underset{\sim}{K} \end{bmatrix} \begin{bmatrix} \underset{\sim}{q}_1 \\ \underset{\sim}{q}_2 \end{bmatrix} = \lambda \begin{bmatrix} \underset{\sim}{0} & \underset{\sim}{M} \\ \underset{\sim}{M} & \underset{\sim}{C} \end{bmatrix} \begin{bmatrix} \underset{\sim}{q}_1 \\ \underset{\sim}{q}_2 \end{bmatrix} \tag{10}$$

If $\underset{\sim}{M}$, $\underset{\sim}{C}$ and $\underset{\sim}{K}$ are symmetric -- this can arise only if damping is structural and assumed to be viscous -- the supermatrices of equation (10) are symmetric, although neither can be positive definite.

TRANSFORMATION METHODS

Jacobi's transformation method predates Caley's first publication on the theory of matrices [35]. However, the Givens and Householder transformation methods published in the 1950s are much more efficient. Recent work has indicated that Givens transformation, previously regarded as inferior, can be implemented with approximately the same efficiency as the Householder transformation [36-39]. Because the matrix requiring eigensolution might be in standard form, the amount of computation is proportional to n^3; these methods are thus unsuitable for large order symmetric problems. Note, however, other work that has been published [40-42]. Less elegant transformation methods have been used extensively in vibration analysis to reduce large order problems to systems with a more manageable number of variables. The mass condensation method is the most well known [43-45]. Because an approximation is inherent in each transformation, the success of the method depends on the way in which each approximation is chosen. Transformations have been used to remove displacement variables for which no mass has been allocated [46, 47]. The only approximations made in these methods are those inherent in the mass and stiffness idealizations. Karpel and Newman [48] have reduced the number of variables in the final overall analysis by first performing eigenvalue analyses of substructures. One transformation method that has not received much attention by those interested in solving vibration equations is Crawford's method. It involves reducing a band symmetric generalized eigenvalue problem to standard tridiagonal form [49] and is used in conjunction with Rutishauser's method [50]. If b is the semibandwidth and $n >> b >> 1$, the amount of computation is proportional to $n^2 b$.

All of the above methods are concerned with symmetric eigenvalue problems. It is much more difficult to obtain stable and reliably convergent methods for unsymmetric eigenvalue problems. The Eberlein extension of Jacobi's transformation method is noted for its lack of universal stability. Attempts have been made to develop stable forms of Eberlein's method [51-53] and to extend the well known QR method to partitioned matrices [54].

The computation of eigenvalues for linear generalized eigenvalue problems having singular or almost singular matrices has received attention. This is of particular relevance for ship, aircraft, and space structures in which the presence of body freedoms gives rise to modes of singularity in the structural stiffness matrix. Transformations that deal with the symmetric (or Hermitian) problem have been sought [55-57]. For general (unsymmetric or symmetric) problems a deflation method of eliminating the modes of singularity has been proposed [58]. A QZ algorithm [59] involves the simultaneous transformation of $\underset{\sim}{A}$ to upper Hessenberg form and B to triangular form; the transformation is followed by an iterative solution of the derived equations in a way that is analogous to the QR method for standard eigenvalue problems. Although variants on the QZ algorithm have been proposed [60, 61], one of the simplest methods is to replace the linear generalized eigenvalue equation (6) by

$$(\underset{\sim}{A} - \alpha\underset{\sim}{B})\underset{\sim}{q} = (\lambda - \alpha)\underset{\sim}{B}\underset{\sim}{q} \tag{11}$$

because $\underset{\sim}{A} - \alpha\underset{\sim}{B}$ will usually be nonsingular even when both $\underset{\sim}{A}$ and $\underset{\sim}{B}$ are singular [62-65].

FREQUENCY SEARCH METHODS

All eigensolution procedures involving $n > 3$ must have an iterative part. The transformation methods previously discussed are not iterative but are useful for reducing some problems to simpler ones; these must be solved by either a frequency search or vector iterative method. The Holzer and Holzer-Myklestad methods were the first frequency search methods used in vibration analysis and are effective for chain type structures; e.g., torsional vibration of shafts, lateral vibration of beams, shear buildings [66, 67]. The methods use matrix transfer techniques that involve mixed displacement and force

variables. It is possible to identify from recent work [68-71] that there is some difficulty distinguishing equal or very close frequencies.

It is not necessary to use the matrix transfer technique, however, because frequency iterative methods can be applied to any of the forms of equations discussed earlier. When the standard matrix eigenvalue problem of equation (3) are written in the form

$$(\underset{\sim}{A} - \lambda\underset{\sim}{I})\underset{\sim}{q} = \underset{\sim}{0} \qquad (12)$$

the required λ values for the matrix $(\underset{\sim}{A} - \lambda\underset{\sim}{I})$ are singular; i.e.,

$$|\underset{\sim}{A} - \lambda\underset{\sim}{I}| = \underset{\sim}{0} \qquad (13)$$

Eigenvalues within any prescribed interval can be obtained by plotting the above determinant as a function of $\underset{\sim}{A}$ and noting the zero crossing points. The main drawback with this method is the possibility that eigenvalues will be missed when multiple or close roots occur; e.g., λ_3, λ_4, and λ_5 in Figure 2 appear as a single crossing point. On the other hand is the Sturm sequence method, in which the signs of the principal minors determine the number of eigenvalues lower than a chosen trial value of λ. Thus multiple eigenvalues can be recognized and close eigenvalues separated. Except for tridiagonal and quindiagonal matrices in which recursive algorithms can be used to evaluate the Sturm sequence [72], the most expedient methods for evaluating the determinant or the Sturm sequence are by forms of triangular factorization. When the matrix has a narrow bandwidth, these methods are relatively efficient and can be implemented in a computer which possesses only a small fast access store.

For dynamic equations (1) in which $\underset{\sim}{K}$ and $\underset{\sim}{M}$ are symmetric it is possible to find the values of ω^2 that satisfy

$$(\underset{\sim}{K} - \omega^2\underset{\sim}{M})\underset{\sim}{x} = \underset{\sim}{0} \qquad (14)$$

Factorization procedures can take advantage of band form if both $\underset{\sim}{K}$ and $\underset{\sim}{M}$ are banded. Determinant search techniques [73, 74], a Sturm sequence technique followed by inverse iteration [75-78], and determinant search, Sturm sequence, and inverse iteration [79-81] have been used. Because the matrix $\underset{\sim}{K} - \omega^2\underset{\sim}{M}$ (ω is a trial frequency) is unlikely to be positive definite, there is a risk that a symmetric $\underset{\sim}{L}\underset{\sim}{D}\underset{\sim}{L}^T$ factorization will lose accuracy. On account of this various measures have been taken: a more complicated unsymmetric factorization [75-77], modification of the symmetric factorization to assure strong pivots [78], retention of symmetry but a shift of trial frequency if tests indicate that loss of accuracy is becoming significant [79-81]. It has been suggested that multiple frequencies should be avoided by destroying any symmetries within the physical problem [74, 82]. One method has been used to solve undamped structures by using a quadratic matrix form [83].

Frequency search methods can be applied directly to equations (2) that have been written in the dynamic stiffness form [84-86]. However, in this case the Sturm sequence principle can be used only if it is specially modified according to a method developed by Williams and Wittrick [5, 12, 87-89]. Their treatment of box type structures is of particular interest.

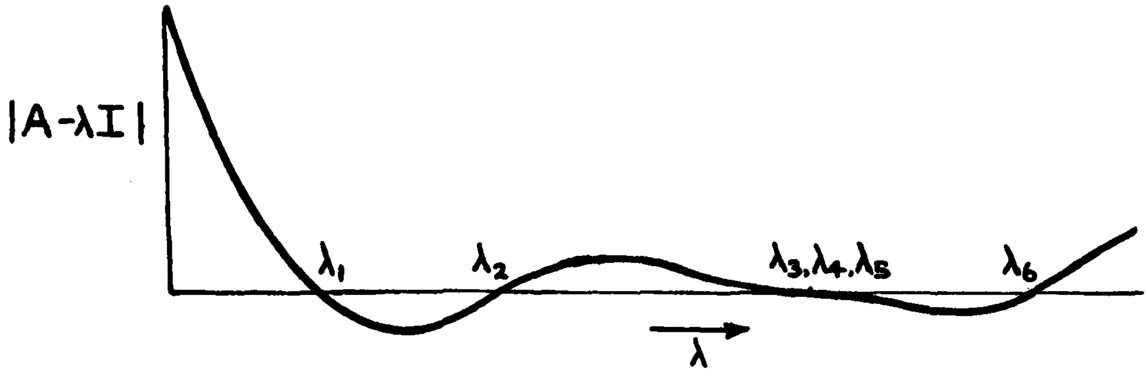

Figure 2. Zero Crossing Points for the Frequency Search Method

Structures of chain form that are amenable to efficient solution by the transfer matrix method also yield stiffness, mass, and dynamic stiffness matrices of narrow bandwidth. Furthermore, because frequency search techniques can have aspects in common, there may not be much to choose between the two approaches. It is most likely that stiffness matrix methods will be preferred to matrix transfer methods because the stiffness matrix is so widely used in static stress analyses. When frequency searches are carried out with large order problems in which the semi-bandwidth b is not small ($n >> b >> 1$), the number of multiplications required using a symmetric factorization technique is approximately $\frac{1}{2}nb^2h$, where h is the number of trial frequency values. Results from any method that does not use the Sturm sequence principle are suspect because there is no guarantee that eigenvalues have not been missed. All the above techniques have been concerned with symmetric eigenvalue problems. Only a limited amount of work has been carried out on the application of eigenvalue search methods to unsymmetric eigenvalue problems [31, 90, 91]; they are complicated by the lack of a Sturm sequence principle and the need to consider complex conjugate pairs of eigenvalues.

VECTOR ITERATIVE METHODS

In contrast with frequency search methods, vector iterative methods use estimates for the shapes of the vibration modes. The earliest method was that of Stodola. From Von Mises' discrete version of this method has been developed the well-known power method for finding the dominant eigenvalue and corresponding eigenvector of a matrix. Many modern vector iterative methods stem from parallel investigations by Jennings [92, 93], Rutishauser [94], and Stewart [95]. All of the investigators recognized the importance of simultaneously carrying approximations to more than one eigenvector and of reorientating the vectors regularly so that each converges onto a different eigenvector. Thus subdominant as well as dominant eigenvalues can be obtained and convergence rates are generally much more rapid for power iteration.

An advantage of vector iterative methods generally is that the matrix whose eigenvalues are being determined is involved only in a multiplication operation and hence does not have to be explicitly available. Thus simultaneous iteration applied to the transformed form of the dynamic equations (4) can be carried out with the mass matrix $\underset{\sim}{M}$ and the factorized stiffness matrix $\underset{\sim}{L}$ in store, taking advantage of sparseness in $\underset{\sim}{M}$ and band structure in $\underset{\sim}{L}$ [17, 62, 96, 97]. Convergence is to the set of lower frequencies. For large order problems with $n >> b >> 1$, the number of multiplications approximates $2nmbk$ where m is the number of vectors carried simultaneously (greater than the number of dominant eigenvalues required) and k is the number of iteration. The fact that there is no b^2 factor in the expression means that, when the bandwidth is large compared with the number of eigenvalues required, simultaneous iteration is much more efficient than frequency search methods. Compared with mass condensation, simultaneous iteration may not be any more efficient, but it does require the handling of lower order matrices, does not depend on a good choice of master displacements, and has an accuracy controlled by means of a tolerance criterion [98]. A similar technique has been used in simultaneous iteration [80, 81, 99, 100], but the method has been applied directly to the dynamic equations (1), thus avoiding a transformation of variables. However, factorization of the stiffness matrix is still required, and the efficiency is similar to that of simultaneous iteration. (Ignore the erroneous claim [99] that one method is very much more efficient than simultaneous iteration for large order systems.) Bathe and Wilson [80, 81, 100] adopted the name subspace iteration. Two independent Chebyshev accelerations of simultaneous iteration have been carried out [101, 102], and various other discussions of simultaneous iteration are available [103-107]. Simultaneous iteration methods have also been extended to standard unsymmetric eigenvalue problems [108-110] and to various generalized eigenvalue problems [111, 112] and have been used for calculating interior eigenvalues [113, 114]. Note also the inverse iteration method of Jensen [115] for interior eigenvalues.

Another class of vector iterative methods derived from the Lanczos algorithm [116, 117] has been developed mainly for symmetric eigenvalue problems. In the Lanczos method the fact that all vectors are mutually orthogonal means that effort is not devoted to performing matrix times vector multiplications, which are almost the same as at the pre-

vious iteration. However, early development of the method was hampered because the implicit orthogonality condition tends to break down in practice, and formal orthogonalization destroys the computational advantage of the method when it is applied to the complete eigensolution of a matrix. Ojalvo and Newmann [118] have applied the Lanczos iteration to dynamic equations (1). The stiffness matrix was factorized once only (as in simultaneous iteration), and a formal orthogonalization was used -- it was computationally justifiable because only a partial eigensolution of a large matrix was sought). Two disadvantages of the Lanczos iteration as opposed to simultaneous iteration are:

- Although the method is competitive insofar as amount of computation is concerned, the mass and stiffness information are required more frequently; on a large computer this requirement likely means more backing store transfer operations
- A set of multiple eigenvalues will generally be recognized only as a single eigenvalue, and difficulty can occur with clusters of eigenvalues

Paige [119] has shown that the Lanczos method can give reliable results without formal orthogonalization although multiple copies of some eigenvalues are obtained. Parlett and Scott [120] have developed an implicit orthogonalization method for economical prevention of this duplication. Specific block and band Lanczos algorithms have been developed to overcome the second disadvantage above [121-124]. The block methods also overcome the first disadvantage and are worthy of consideration for vibration analysis of large order systems. Chowdhury [125] has proposed that Lanczos vectors could be used in place of normal modes as basic variables in dynamic response calculations.

In the case of dynamic equations derived using a lumped mass idealization the transformation of equation (5) yields a sparse matrix $\underset{\sim}{G}^{-1}\underset{\approx}{KG}^{-T}$ (because $\underset{\sim}{G}$ is a diagonal matrix); the lower eigenvalues correspond to the lower frequencies of the system. There is clearly the possibility of finding these eigenvalues (or at least the lowest one) without resorting to a matrix factorization, for instance by applying a linear or higher order shift such that the eigenvalue(s) required will be dominant [126, 127]. Unfortunately the eigenvalues will tend to be extremely close; thus the deficit of a very much poorer convergence rate will have to be weighed against the advantages gained in storage space and amount of computation per iteration. The same consideration also applies to Allman and Brotton's relaxation method [128] for lumped mass systems and to McCormick and Noe's simultaneous iteration with iterative factorization [129].

The Lanczos algorithm has the interesting property that convergence is obtained to lower as well as higher eigenvalues [130]. It could therefore be so used to be more effective than conventional iterative techniques. It has been used in nuclear physics for large sparse matrix eigensolutions in which there is no obvious band structure to facilitate factorization [131]. Several other methods of obtaining the lowest eigenvalues without factorizing the matrix have been published [78, 132-137]. Davidson's method is claimed to be better than the MOR method [134] and Lanczos' method although the number of trial problems quoted is small and its theoretical justification appears to be weak. (A perturbation approximation results in the denominator $(\rho - a_{ii})$ appearing in an expression whose value is to be computed. There does not appear to be any guard against this denominator becoming zero or very small.) The coordinate relaxation methods therefore seem to be the most firmly established in this field [19].

OTHER CONSIDERATIONS

Most publications have been concerned with advocating particular algorithms. A few provide reasonably objective comparative studies [78, 80, 98, 100, 111]. There have only been limited discussions of bounds [115, 138-140], sensitivities [141-143], and the effects of minor modifications [144, 145]. The ways in which it might be possible to take advantage of parallel computers require urgent attention [146].

CONCLUSIONS

Symmetric eigenvalue methods that can be used for frequency analysis of undamped vibration problems are the most highly developed. For large order problems with sparse mass and stiffness matrices frequency search or vector iterative methods should

be considered. For frequency search methods, in which bandwidth of the matrices is large, it is important that frequencies be isolated with as few factorizations as possible by making effective use of determinant search, Sturm sequence, and inverse iteration techniques. Of vector iterative methods, those involving simultaneous iteration (including subspace iteration) have been well developed for vibration analysis. They are effective when the lowest few frequencies are required and are more economical than frequency search methods if bandwidths of the matrices are large. However, Lanczos methods are very promising, and such recent modifications as block Lanczos might be very useful in vibration analysis. The use of dynamic stiffness matrices, particularly with the Sturm sequence method developed by Williams and Wittrick is of importance in vibration analysis of framed and box type structures.

Most damped vibration problems require an unsymmetric eigenvalue method. The effective choice is between transformation techniques – unsuitable for large order problems – simultaneous iteration, and Gupta's eigenvalue search methods.

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LITERATURE REVIEW

survey and analysis of the Shock and Vibration literature

The monthly Literature Review, a subjective critique and summary of the literature, consists of two to four review articles each month, 3,000 to 4,000 words in length. The purpose of this section is to present a "digest" of literature over a period of three years. Planned by the Technical Editor, this section provides the DIGEST reader with up-to-date insights into current technology in more than 150 topic areas. Review articles include technical information from articles, reports, and unpublished proceedings. Each article also contains a minor tutorial of the technical area under discussion, a survey and evaluation of the new literature, and recommendations. Review articles are written by experts in the shock and vibration field.

This issue of the DIGEST contains articles about turbomachine blade vibration, and vibromotors.

Professor J.S. Rao of the Indian Institute of Technology, has written an article on turbomachine blade vibration. In the article, he reviews the literature on blade excitation forces, vibration of blades with large aspect ratio and small aspect ratio, blade group vibration, blade damping and response, and experimental methods.

Prof. dr. K.M. Ragulskis of the Kaunas Polytechnical Institute, has written an article on vibromotors. Some of the publications on vibration converters, in particular, vibromotors, are reviewed.

TURBOMACHINE BLADE VIBRATION

J. S. Rao*

Abstract. This article reviews the literature on blade excitation forces, vibration of blades with large aspect ratio and small aspect ratio, blade group vibration, blade damping and response, and experimental methods.

Methods for determining natural frequencies of turbine blading have been reviewed [48], as have turbine blading excitation and vibration [49]. Other reviews have appeared in the past three years [26, 27, 54, 65, 77, 86]. This article reviews methods used to study theoretical and experimental aspects of the blades used in turbomachinery, particularly work reported in the past three years.

BLADE EXCITATION FORCES

For unsteady flows around stationary airfoils, Goldstein and Attasi [19] have given a complete second order theory of the Sears problem; they considered compressible flow with a convected sinusoidal gust. Coupling of the amplitude of unsteady incident disturbance with the angle of attack and camber/thickness of the airfoil was included. The problem of a convecting stream-wise gust has been extended to account for a non-convecting gust for both parabolic [60] and generalized camber airfoils [58].

An analysis [32] based on a simple model has been used to determine the unsteady lift on a cascade of airfoils moving through circumferential low frequency inlet distortions. A simple method for calculating unsteady forces on flat plate airfoils in a cascade moving through sinusoidal gusts has been given [39]; the acceleration potential method was used in conjunction with conformal mapping. Namba [45] has stated a hypothesis for predicting unsteady blade forces caused by inlet distortions in a rotating subsonic annular cascade. Holmes theory for a non-convecting stream-wise gust on flat plate airfoils was used to analyze and develop computer programs to determine the unsteady forces of stator and rotor blades of an elementary turbomachine stage [58]. The effect of parabolic camber was subsequently considered [60, 63] on the basis of other work [61]. An analysis for thin airfoils with generalized camber [59] and numerical results for skew mean line cambered blades of a stage [62] are available. Theoretical aspects of blade forces in a turbomachine stage have been presented [50, 68].

Vortex theories developed to determine unsteady forces in a turbomachine stage are not directly applicable to a practical stage because of the assumptions involved. Hydraulic analogy might prove to be a good tool for designers in this field. Design and development of a rotating water table for flow studies in turbomachinery have been discussed [72], and modeling techniques and experiments on three different turbine stages have been reported [70]. Several U.S. Navy reports on blade tests have been reviewed, water table tests for LP turbine stage geometry have been given, and unsteady flow visualization techniques have been discussed [71]. A preliminary comparison of water table tests with results from a computer program was also presented.

FREE VIBRATION CHARACTERISTICS OF BLADES

Desilva and Grant [11,12] compared some optimal control methods for the design of turbine blades. They used a Timoshenko beam model; some computational difficulties were discussed, and a differential dynamic programming approach was suggested. Bishop and Price [8] considered coupled bending and twisting of a Timoshenko beam; they established orthogonality conditions of principal modes and derived modal equations for forced vibration. Large deformation of a cantilever under gravity tip load

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has been considered at various angles with respect to principal beam axes [14]. Experimental data were compared with nonlinear structural theory; good correlation was found for small deformation. Banks and Kurowski [4] considered transverse vibrations of a doubly tapered beam. Singh and Rawtani [78] solved the classic wave equation considering root stiffness at a fixed boundary.

Flexural vibrations of pretwisted rotating blades have been considered [82, 83] using the Rayleigh-Ritz method; shear deformation and rotary inertia were included. Coupled bending torsional vibrations, including shear and rotary inertia, have been studied [51, 56]. Simple relations to determine the natural frequencies were used to examine the effects of disc radius, rotational speed, asymmetry of cross section, and stagger angle. Rao [52] used the Galerkin method to study coupled bending torsional vibrations of pretwisted asymmetric blades mounted on a rotating disc at a stagger angle; design charts were given. The study has been extended to development of a general computer program for a free-standing blade having specified sectional properties [53]. Zuladzinski [90] used a work-energy formulation to determine the effect of rotation on fundamental frequency.

Rao and Banerji [55] used a polynomial frequency equation approach for coupled bending-torsional vibrations of a blade to avoid a root searching trial and error procedure. Dawson and Davies [10] developed an automatic root searching procedure for the Myklestad method for vibration analysis of blades. Downs [15] described a new dynamic discretization technique and considered transverse vibrations of cantilever beams having unequal breadth and depth tapers. Influence coefficients and matrix algebra have been used to develop a general computer program for a helicopter rotor blade to determine the first three bending modes and uncoupled fundamental torsional mode [89]. A point transmission matrix method has been used for a similar problem in which a mass is attached to a rotor blade [41]. The point transmission matrix method was also used to determine the dynamic characteristics of a vertical plane pendulum on a rotating blade undergoing bending-bending-torsional motion.

A finite element formulation of rotating pretwisted tapered beams with elements having five degrees of freedom is available [40]; the result for the fundamental mode was compared with the Galerkin formulation. Pretwisted beam elements have been studied using approximations of displacements in fixed directions [13]; tapered twisted Timoshenko beam elements were given [24]. Putter and Manor [47] have presented a high precision rotating beam element based on the fifth degree polynomial; they included the effects of shear and rotary inertia and tip mass.

Jumaily and Faulkner [2] considered a thin shell theory for long hollow blades and compared the results with beam theory and laboratory tests; Gupta and Rao used thin shell theory to formulate energy expressions and derived differential equation using a Levy type analysis for torsional vibrations [21] and bending vibrations [22] of pretwisted cantilever plates. Because fundamental mode frequency variation with pretwist is controversial, they used inextensional analysis for bending vibrations [23] and showed that, for small aspect ratio blades, the natural frequency decreases with pretwist. The analysis was extended to rotating pretwisted shells mounted on a disc at a stagger angle [20].

MacBain [35] described a technique for computing the bending strain resulting from resonant modal deformation of a plate and compared the results with those from a NASTRAN finite element program. Isoparametric thick shell elements that allow arbitrary changes in shape thickness and curvature have been used in vibration analysis of impellers of rotating hydromachines [44]; good agreement with experimental results by holography was shown. Walker [88] used conforming finite shell elements for curved twisted fan blades; Mindlin's theory was used to derive the finite elements.

BLADE GROUP VIBRATION

Rieger and Nowak [69] have developed a three-dimensional finite element model of the blade root and wheel root that incorporates gap elements at the root interface. This so-called super element can be used to generate automatically the mesh for the remaining blades of a group so that natural

frequencies and mode shapes can be determined. A finite element model of a group of blades with rectangular cross section has been presented in the tangential mode [85]. Salama and Petyt [75] used the finite element method and periodic structural analysis for the tangential vibration of packeted blades; both the position of the lacing wire and rotation were taken into account. Rieger [66] recently used the ANSYS program to determine natural frequencies of packeted blades of marine turbines; the model includes the effect of tenon and cover and gap elements at the root junction; the results were in good agreement with rap tests conducted on the blades.

Ewins [16] has summarized a series of investigations to explain and predict the types of vibration response exhibited by bladed disc assemblies. Kirkhope and Wilson [33] have used the finite element method to study a large number of identical tapered and twisted blades around an arbitrary (moderately thick) profile disc, taking into account rotation, thermal stress, transverse shear, and rotary inertia. Shell elements have been used for blades, annular sector elements for discs, and a lumped mass with straight beam elements for the shroud in another study [37].

BLADE RESPONSE

A major problem restricting present blade response calculations is lack of suitable damping values. A comprehensive proposal for determining the root damping in a blade group has been made [64]. A rig for determining such damping utilized thermal expansion of a flexure link connecting two blades to simulate thermal loading [67]. Many tests were conducted on three different stages of blades to study the effects of axial load, blade tip displacement, and environmental conditions. Another rig has side bars cooled by circulation of cold petrol [76]. Insertion of a two blade assembly at the lower temperature followed by expansion of the side bar at room temperature provided the required axial load. Damping values were obtained in the fundamental mode of blades of two different stages of a steam turbine with T-root and finger root construction. Rogers and Parin [73] provided damping by bonding several alternate layers of aluminum foil and appropriate viscoelastic adhesives; they controlled vibration-induced cracking of inlet guide vanes of a TF 30 engine. Rieger [65] has reviewed steam turbine blade damping literature and concluded that no meaningful technical development has occurred in the last 20 years. Jones discussed two decades of progress in damping technology [26]; he has also described the use and possible long-term stability limitations of viscoelastic materials in the dove tail [27]. Finite element analysis has been used to predict modal damping in a jet engine high-pressure compressor stator vane with an enamel coating; the results agreed with experimental observations [87].

Jones [25] considered a simple analytical model of a vibrating jet engine compressor blade using modal analysis; he allowed for slip at the root. The analysis predicted the minimum frictional force needed to avoid infinite amplitudes under high level excitation. The analysis was extended to a two mass model; results were nonlinear when slip occurred beyond a threshold level at the root [28]. Jones and Muszynska [29] refined the model by assuming that one mass moves in the space between two elastic noninertial buffers; the motion of the masses is damped by dry friction, fluid pumping in gaps, and hysteretic damping of elastic members. An external harmonic force was considered. Approximate nonlinear equations of motion were derived for a blade with low frictional forces at high speeds; a gap introduced closed up only at high speeds [30]. Slip at the root and hysteresis of the blade were considered further [31] and compared with experimental response data. A refined discrete model was given subsequently [43].

A theoretical analysis has defined loading and response of a rotor fan blade due to soft impacts in terms of three fundamental modes [9]. Reissner's method has been used to determine the deformation of a cantilever under steady lateral force [3]. Response of the airfoil cross section of rotating blades due to flow excitation has been studied using the Rayleigh-Ritz method [57]; viscous damping was assumed. Forced and self-excited vibration of blades in a stage due to flow interference have been considered [38]. Macbain [34] used the finite element method to determine transient response of a cantilever plate subjected to normal impact by a ballistic pendulum. The ANSYS program has been used to determine dynamic stresses of a blade group due to flow path excitation [69]. Salama and Petyt [75] used the finite element method to determine the

response of a packet of blades to harmonic excitation of different engine orders. Component modal analysis has been used for a typical fan design [80]; viscous damping due to rubbing of the shroud interfaces was included. Fabunmi [17] used a semi-empirical method that utilized modal analysis and was based on experimentally obtained mode shapes; he determined the vibration response of a 23-bladed axial compressor rotor.

EXPERIMENTAL METHODS

Experimental methods used to determine power spectral densities (hense stresses) from local strain measurements have been described [6]. Applications of holography to turbine blade vibrations have been discussed [79], and holographic interferometry has been used to obtain the transient response of platelike structures [34, 35]. Test results of an optical measuring instrument developed to measure turbine blade vibration have been reported [74].

A new technique for measuring blade deflections uses small blade-mounted mirrors that reflect light once per revolution [81]. Optical measuring procedures that use stroboscopic imagery of the blade tip and photoelectric scanning of blade tip motion have been discussed as have conventional dynamic strain gage measurements [46]. Frei [18] designed and built a special gas turbine rotor to measure compressor blade vibrations; he used strain gages. An optical interferometric technique has been used to measure both bending and torsion of a gas turbine compressor blade over the entire 360° of rotation [5]. A telemetry system was used in an experimental study of the vibratory behavior of steam turbine blades at 150°C [7]. Adler [1] has described forthcoming developments in telemetry for rotating measurements on turbomachinery. Masuura [36] made an experimental study of forced vibration of a cascade of blades due to upstream periodic wakes. Other instrumentation for measurements on rotating blades uses piezoelectric crystals with specially designed differential amplifiers to reject noise and cross-talk in slip rings [84]. Sensitive instrumentation for measuring very small order unsteady forces of three turbine stages uses the hydraulic analogy on a water table [70].

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VIBROMOTORS

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Abstract - Devices that convert oscillations into reciprocating, rotary, or complex multi-dimensional motion of a driven link are employed as actuators. The development of new designs and the mechanisms of transformation of high-frequency oscillations have made these devices very popular. Some of the publications on vibration converters, in particular, vibromotors, are reviewed in this article.

Vibromotors are used in rotary and reciprocating motion; for motion in two coordinates and planar rotation; for complex three-dimensional motion; and for driving solids, flexible tapes, and liquids.

Vibromotors have been used successfully in recording and reproducing devices [13], for moving magnetic tapes [12, 14], and for transferring liquids [24, 33].

According to existing classifications [19, 20], machines based on piezoelectric drives can be classed as either static or high-frequency (resonant). Resonant drives can be subdivided in several ways, based on the use of an oblique impact; asymmetrical oscillation cycles when simultaneous use of nonlinear properties of liquids is made; development of a discrepancy within the limits of a normal reaction cycle; a periodically varied connection between the oscillating part and the rotor or the driven body using either electro or magneto-viscous liquids or materials with a controllable coefficient of friction; and frictional interaction between an elastic body performing an undulatory motion and the driven part.

Static machines are conventional positioning devices provided with electromechanical converters. An object is driven as a result of deformation of a converter; deformation is brought about by creating electric and magnetic fields.

Vibromotors, which transform oscillatory motion, are devices in which a driven object interacts with an elastically oscillating element that is a resonance vibroexciter. This device depends on an oblique impact: a driven object is moved by an oscillating element that can be a piezoceramic plate or an ultrasonic concentrator elastically fixed to a driven object.

Certain vibromotors make use of asymmetrical oscillations to produce a guided motion [19]. An oscillating element generates asymmetrical oscillations, for example, bi-harmonic. An object is driven by the nonlinear force of the dry friction.

In vibromotors based on the imposition of a normal reaction between an oscillating part and a rotor so as to achieve a difference in the limits of one basic reaction cycle, oscillations are generated in two planes. The rotation or stepping motion of a driven link is performed by two piezoceramic converters placed at an angle and connected by a shoe contacting a rotor.

Machines in which the driving force involves transformation of a normal reaction are referred to as having two active elements in the contact zone [20, 21]; they differ from machines with one active element in the contact zone in that the driving force is generated by the oscillating interaction of two contacting converters. A linear motor is designed on this principle; its resolution is 0.02 micrometer.

In some vibromotors transformation of high frequency oscillations into guided motion occurs with electro-viscous liquids, materials that change in viscosity when subjected to an electric field. The viscous friction force changes within the oscillation cycle limits.

Vibromotors based on transfer by wave oscillation [19, 21] can be divided into two groups. Vibro-

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motors in one group generate a transverse moving wave in an elastic element; those in the second group depend on the motion produced by longitudinal moving waves [22]. The designs of these machines are analogous, but those in the first group operate in transverse resonance systems; the others operate in longitudinal resonance systems.

Machines based on interaction with an undulatory motion produce a rotary motion. An undulatory machine with a rotary motion in which an undulatory resonance vibrator is bimorphic is an example [17]. Increased velocity is achieved by generating oscillations of various frequencies in driving and driven links [16]. In an element under strain a moving wave of high-frequency is being generated; oscillations are transferred to a driven element in the vertical direction with a frequency different from that of a moving wave.

A synchronous converter has an annular converter in which a moving wave is generated; the annular converter is fixed to the rotor. An additional piezoelement operates at a frequency different from that of the annular converter. These devices are used in systems requiring constant velocity.

Reversal of undulatory vibromotors is accomplished by changing the direction of wave propagation.

Vibromotors require a drive with several movable oscillations provided by piezoelectric converters. Resonant longitudinal oscillations of any harmonics are easily generated in rod converters. Division of the converter electrodes according to length makes it possible to generate either bending oscillations or bending and longitudinal oscillations simultaneously. In cylindrical converters radial and torsional oscillations can be generated as well as bending ones of the moving wave type.

Vibromotors possess a number of advantages over classical drives. They meet the requirements of precise mechanics because of their rigidity, absence of gaps, motion operation with the least number of driving links, and the possibility of independent motion control in each coordinate. The main advantages of vibromotors are their high resolution -- up to 0.01 micrometer -- and their ability of control motion parameters within a wide range. The ratio of maximum and minimum speeds is 10^7. The principal applications of vibromotors are in precision instrument engineering, automatics, and telemechanics. According to the character of the work performed and the modes of motion vibromotors may be classified into various types. Machines with continuous motion include vibromotors with linear and rotory motion. They are used in tape drives, precise rotors, disk memories, and actuators. Vibromotors are usually employed in speed feedback systems. In positioning devices typical vibromotor properties include high resolution and a low time constant. These machines are used for angular positioning/dividing machines and for linear positioning. Resolution is of the order of 0.01 micrometer. They are usually applied to position feedback systems.

Because of speed and acceleration control vibromotors can be used successfully in designing gyroscopes and scanning systems, in astronomical engineering, and for reproducing periodic laws of motion. Vibromotor designs are now available with up to six degrees of freedom. They are effective in micromanipulators of high accuracy. Devices that position in plane and space fall into this group. The important feature of these designs is their multimode operation. Continuous motion, precise stopping, and imposition of periodic oscillations for orienting or reducing frictional forces are accomplished.

Many vibromotor applications depend upon specific features. Various problems of motion stabilization, wiring of memory matrixes, and rolamites provided with a controlled moment of resistance to motion are examples.

At present several basic design schemes of vibromotors meet the requirements of precise engineering. However, the development of new piezoelectric and structural materials will lead to the further improvement of vibromotor designs. Among the aims to be fulfilled are:

- the search for new piezoelectric materials having values for electromechanical drive factors.
- the synthesis of piezoelectric materials having controllable dynamic quality.
- the elaboration of flexible piezoelectric materials.

- the application of powerful magnetostrictive converters for widening the application of vibromotors; for example, in machine-tool construction.

A number of actuators exist for transfer of fluids [32, 33]. Fluid is transferred with the help of wave oscillations by an operational element such as a pipe or a recess. The oscillations are generated by high-frequency piezotransducers, the operating frequency of which is within the limits of 20-60 kHz.

These vibromotors are distinguished for their reliable and noiseless operation, the absence of rubbing elements and units, simple design, small size and low weight, and smooth adjustment of drives and head of driven fluid.

Vibropumps are used in precise systems of a hydrodrive. They can be employed in automatic control systems and in medicine.

Vibropulverizers are used in various branches of engineering; for example, in robot engineering for automatic lubrication of parts and units, in growing plants in a closed environment, in medical equipment for dispensing medication, in climatic equipment for formation and maintenance of given relative humidity.

Theoretical and experimental investigations carried out with vibromotors are based on the effect of an oblique impact [3, 4, 19, 27], the interaction bebetween two oscillating elements [23], and the effect of high-frequency wave motions [7-10, 20, 21]. The conditions of existence and stability as well as their basic dynamic characteristics under transient and steady-state conditions of motion are determined. Continuous and stepping modes of operation have also been studied [30].

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BOOK REVIEWS

DEVELOPMENTS IN THEORETICAL AND APPLIED MECHANICS
Vol. 9, Proceedings of the Ninth Southeastern Conference in Theoretical and Applied Mechanics

Vanderbilt University, Nashville, Tennessee, 1978

This volume contains the papers presented at the conference sponsored by Vanderbilt University during 4-5 May 1978 and held at Nashville, Tennessee. These conferences were initiated in 1962 for the purposes of stimulating interest in mechanics, of providing a means of formal and informal exchange of ideas, and for sharing recent research results.

The keynote address, delivered by Prof. J. Tinsley Oden, was entitled "On the Convergence and Accuracy of Finite Element Approximations in Finite Elasticity." The various sessions featured recent work in the following areas: dynamics, plastic analysis, fluids, vibrations, fracture, beams and plates, special topics, stability, and material behavior.

The papers are of very good quality; it is unfortunate that, because current reviewing procedures -- such as listing in "Current Contents in Engineering, Technology and Applied Sciences" -- are not extended to publications other than journals, it is likely that a number of researchers will miss these and similar contributions to congresses, conferences, and symposia. This stresses the importance of continuing the review of proceedings and transactions of such meetings. At present Applied Mechanics Reviews and the Shock and Vibration Digest perform this task for the engineering community.

Of considerable interest to this reviewer was a paper by Prof. H.H.E. Leipholz on "An Energy Approach to Stability Problems of Nonconservative Systems"; it is based on an abstract originally presented at the Sixth Canadian Congress of Applied Mechanics and appeared in that proceedings.

It is hoped that papers of such quality will serve to raise the status of such conference proceedings to that of a refereed professional journal. This would encourage researchers in mechanics to read such publications regularly and the review journals to review them.

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A MODERN COURSE IN AEROELASTICITY

E.H. Dowell, editor and author
H.C. Curtiss, Jr., R.H. Scanlan, F. Sisto, co-authors
Sijthoff and Noordhoff; The Netherlands, 1978

This comprehensive textbook of some 460 pages is one of a series by the Publisher on the mechanics of dynamical systems. The first four Chapters ("Introduction," "Static Aeroelasticity," "Dynamic Aeroelasticity," "Nonsteady Aerodynamics of Lifting and Non-Lifting Surfaces") are written by E.H. Dowell and include the first 266 pages. The remaining Chapters are written by his co-authors: "Stall Flutter" by Sisto (13 pages); "Aeroelastic Problems of Civil Engineering Structures" by Scanlan (45 pages); "Aeroelastic Problems of Rotorcraft" by Curtiss (55 pages); and "Aeroelasticity in Turbomachines" by Sisto (26 pages). Two appendices contain information on structural response to random pressure fluctuations and some example problems.

The first three Chapters present simple physical concepts of such static and dynamic aeroelastic phenomena as divergence, aileron reversal, rolling effectiveness, and flutter and gust response of aircraft wings; brief consideration is given to a complete aircraft. Various non-aerofoil problems are also considered -- divergence (buckling) and flutter

of flexible pipes containing a fluid flow and of flexible panels with a flow over one surface. Simple one-dimensional and two-dimensional representations are used; the several analytic approaches presented enable the reader to follow readily both the concepts and the methods.

Aerodynamic forces for aerofoils are introduced in the third Chapter. The fourth Chapter is concerned exclusively with non-steady aerodynamics. The treatment is comprehensive and should not only give the student an adequate grounding for further study but also provide the experienced practitioner with an excellent state-of-the-art review.

The remaining Chapters contain excellent surveys of relevant physical concepts and their applications; their inclusion in a textbook on aeroelasticity is novel. Their value to experienced practitioners probably exceeds that to the student for whom such a degree of coverage and specialization is not necessary. Chapters 1, 2, and 3 are a must for aeronautical engineering undergraduates; Chapters 4 and 5 cover additional essential material at the graduate level. Chapter 6 on divergence, galloping, vortex shedding, flutter, and buffeting is for civil engineering graduates; Chapters 7 and 8 would be of equal value to aeronautical and mechanical engineering graduates.

Chapter 7 covers blade dynamics, stall flutter, and blade/body coupling. Chapter 8 covers aeroelastic environment, compressors, blade mode shapes, non-steady potential flow in cascades, compressible flow, periodically installed flow, stall flutter, choking flutter, supersonic bending, and torsional flutter. As is true with almost any textbook, the reviewer can point to apparent omissions or shallowness of treatment; however, such criticism would be unfair in this case because the book claims only to emphasize fundamentals and does not claim comprehensiveness. There are a number of typographical errors, but they are generally obvious and not confusing. Overall the reviewer believes that this book is a useful addition to the literature and will enable the teacher, student, and practitioner to select topics of interest for study.

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NOISE CONTROL IN INDUSTRY

J.D. Webb, editor
John Wiley and Sons, Inc., New York, NY, 1976

This book, published in England by the same consulting firm that published Noise Control in Mechanical Services in 1972, is a joint endeavor by 14 people; the authorship of each chapter is not given. The editor states that the book "is an attempt to provide a basic understanding of noise control," but it is apparent that a good textbook would be a valuable supplement. The 24 chapters can be grouped into three categories: acoustics, noise control, and applications.

The chapters on acoustics (including vibration basics) are probably best described as a set of lecture notes. Because they are not at all scientifically rigorous, the reader must refer to other sources for precise information. For example, a figure indicates that damping always results in lower sound absorption coefficients, but the text contradicts this; high frequency sounds are defined as high pitched sounds, and the author states that if the intensity of a sound wave increases, so does its loudness. The chapter on noise and the law (British law) is interesting but not especially germane to non-British readers. The chapter on vibration theory does not have the equation for a single-degree-freedom system; the sound and vibration measurement section is far too superficial, providing little information on some of the equipment used to measure sound pressure and acceleration. Only one sound level meter is pictured in this chapter, and a table that compares microphones shows that electret types are superior in all categories to other types.

The sections dealing with noise control are mostly descriptive in nature but contain useful discussions of many of the considerations necessary for understanding noise control. Worked out examples are educational but simplistic for real world problems. A chapter on attenuators is adequate and contains practical tips for designing reactive silencers. The vibration control chapter supplements the chapter on vibration basics. It has much useful information including a discussion on isolator selection. Information on acoustical aspects of thermal insulation and fire control are not usually found in books of

this type. I also liked the discussion on functional (suspended) absorbers.

The applications sections contain discussions of pumps, diesel engines, exterior noise, electrical equipment, air handling systems, gas turbines, interior noise, trucks, and valve noise. Most of the information is descriptive in nature; the figures are similar to those published in other books. Nevertheless, they are especially useful for readers that are only occasionally asked to provide noise/vibration control.

The book contains a bibliography, two appendices, a listing of terminology, and an index. The bibliography contains reference to 104 sources, many with incomplete citations (such as missing publication dates). One appendix consists of a short conversion table from British units to metric; the other is a listing of the Sound Reduction Index (TL) of some representative materials and constructions used in industrial situations. I could not find the appendix on sound absorption coefficients that was referenced in the text. It would have been a useful addition to this book, especially if it contained some values of plastic-film-faced glass fiber and other common, but not standard, absorbing materials. The index is small and barely adequate. It reflects, as does the other language in the book, British convention; hence, transmission loss, sound transmission class, and similar terms are not in the index.

Overall, the book is uneven and, in general, sloppily written: several equations are incomplete, some tables and figures are mislabeled or poorly explained, and a few sentences are unintelligible. The chapter on acoustical treatment of rooms has enough graphs without numerical scales to make me question if indeed the author(s) ever had any actual data points. Still, there are several good worked-out examples scattered throughout the book, and many discussions are quite well done. Noise Control in Industry might be helpful to an experienced practitioner of noise control in need of some review in one area or an expert in, say, architectural acoustics who desires to learn about industrial noise.

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SHORT COURSES

FEBRUARY

FIXTURE DESIGN FOR VIBRATION AND SHOCK TESTING

Dates: February 11-15, 1980
Place: Santa Barbara, California
Dates: March 10-14, 1980
Place: St. Petersburg, Florida
Objective: The relative merits of various types of shakers and shock test machines are briefly considered, with most emphasis on electromagnetic shakers. The seminar will be devoted to practical and proven simplified design and fabrication techniques. An important area to be covered is that of evaluating a fixture once it is built.

Contact: Wayne Tustin, Tustin Institute of Technology, 22 East Los Olivos St., Santa Barbara, CA 93105 - (815) 682-7171.

MACHINERY VIBRATION ANALYSIS

Dates: February 12-14, 1980
Place: San Diego, California
Dates: April 9-11, 1980
Place: Chicago, Illinois
Dates: June 18-20, 1980
Place: Houston, Texas
Dates: August 26-28, 1980
Place: Las Vegas, Nevada
Dates: December 10-12, 1980
Place: New Orleans, Louisiana
Objective: The course covers causes, effects, detection, and solutions of problems relating to rotating machines. Vibration sources, such as oil and resonant whirl, beats, assembly errors, rotor flexibility, whip, damping, eccentricity, etc. will be discussed. The effect on the overall vibration level due to the interaction of a machine's structure, foundation, and components will be illustrated.

Contact: Bob Kiefer, Spectral Dynamics, P.O. Box 671, San Diego, CA, 92112 - (714) 268-7100.

FINITE ELEMENTS IN BIOMECHANICS

Dates: February 18-21, 1980
Place: Tucson, Arizona
Objective: As a forum for the exchange of ideas, for the definition of the state-of-the-art, and for the presentation of new research results in biomechanics.

Contact: Professor Bruce R. Simon, Dept. of Aerospace and Mechanical Engineering, College of Engineering, The University of Arizona, Tucson, AZ 85721 - (602) 626-3752/626-3054.

BALANCING OF ROTATING MACHINERY

Dates: February 26-28, 1980
Place: Shamrock Hilton, Houston, Texas
Objective: The seminar will emphasize the practical aspects of balancing in the shop and in the field. The instrumentation, techniques, and equipment pertinent to balancing will be elaborated with case histories. Demonstrations of techniques with appropriate instrumentation and equipment are scheduled. Specific topics include: basic balancing techniques (one- and two-plane), field balancing, balancing without phase measurement, balancing machines, use of programmable calculators, balancing sensitivity, flexible rotor balancing, and effect of residual shaft bow on unbalance.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254/654-2053.

MARCH

FINITE ELEMENT METHOD AND COMPUTER GRAPHICS IN STRUCTURAL MECHANICS

Dates: March 10-14, 1980
Place: The George Washington University
Objective: This course is designed for engineers and scientists who are required to perform detailed stress analysis of complex structures without homogeneous

and isotropic properties. The course will cover the theory and applications of finite elements for discrete structural systems and continua. Topics to be covered will primarily consist of the linear and nonlinear behavior of structural frames, plates, and shells. Emphasis will be on computer applications and computer graphics techniques.

Contact: Continuing Engineering Education Program, George Washington University, Washington, D.C. 20052 - (202) 676-6106 or toll free (800) 424-9773 or TELEX 64374.

MEASUREMENT SYSTEMS ENGINEERING

Dates: March 10-14, 1980

Place: Phoenix, Arizona

MEASUREMENT SYSTEMS DYNAMICS

Dates: March 17-21, 1980

Place: Phoenix, Arizona

Objective: Program emphasis is on how to increase productivity, cost-effectiveness and data-validity of data acquisition groups in the field and in the laboratory. Emphasis is also on electrical measurements of mechanical and thermal quantities.

Contact: Peter K. Stein, 5602 East Monte Rosa, Phoenix, AZ 85018 - (602) 945-4603/946-7333.

DIGITAL SIGNAL PROCESSING

Dates: March 11-13, 1980

Place: San Diego, California

Dates: October 21-23, 1980

Place: Atlanta, Georgia

Objective: The mathematical basis for the fast Fourier transform calculation is presented, including frequency response, impulse response, transfer functions, mode shapes and optimized signal detection. Convolution, correlation functions and probability characteristics are described mathematically and each is demonstrated on the Digital Signal Processor. Other demonstrations include spectrum and power spectrum measurements; relative phase measurements between two signals; and signal source isolation.

Contact: Bob Kiefer, Spectral Dynamics, P.O. Box 671, San Diego, CA 92112 - (714) 268-7100.

BOUNDARY INTEGRAL EQUATION METHODS

Dates: March 17-22, 1980

Place: University of Arizona, Computer Center

Objective: The objective of this short course is to introduce the Boundary Integral Equation Method (BIEM) as an efficient numerical tool for the solution of various types of ground-water problems. The course is designed to provide a working knowledge of the BIEM so that the participants will be able to use and modify the existing computer programs and to develop their own programs for their specific problems.

Contact: Professor James A. Liggett or Professor Phillip L.-F. Liu, School of Civil and Environmental Engrg., Cornell University, Hollister Hall, Ithaca, NY 14853 - (607) 256-3556/256-5090 respectively.

EXPLOSION HAZARDS EVALUATION

Dates: March 31-April 4, 1980

Place: Southwest Research Institute

Objective: This course covers the full spectrum of problems encountered in assessing the hazards of accidental explosions, in designing the proper containment as necessary, as well as developing techniques to reduce incidence of accidents during normal plant and transport operations. Specific topics to be covered are: fundamentals of combustion and transition to explosion; free-field explosions and their characteristics; loading from blast waves; structural response to blast and non-penetrating impact; fragmentation and missile effects; thermal effects; damage criteria; and design for blast and impact resistance.

Contact: Wilfred E. Baker, Southwest Research Institute, P.O. Drawer 28510, San Antonio, TX 78284 - (512) 684-5111, Ext. 2303.

APRIL

VIBRATION AND SHOCK SURVIVABILITY, TESTING, MEASUREMENT, ANALYSIS, AND CALIBRATION

Dates: April 7-11, 1980

Place: Dayton, Ohio

Objective: Topics to be covered are resonance and

fragility phenomena, and environmental vibration and shock measurement and analysis, also vibration and shock environmental testing to prove survivability. This course will concentrate upon equipments and techniques, rather than upon mathematics and theory.

Contact: Wayne Tustin, 22 East Los Olivos St., Santa Barbara, CA 93105 - (815) 682-7171.

ACOUSTICS AND NOISE CONTROL

Dates: April 14-18, 1980

Place: The University of Tennessee Space Inst.

Objective: This is an introductory course dealing with the fundamentals of vibration and noise control. The equations governing the vibrations of continuous systems and sound propagation will be developed and certain elementary solutions derived to illustrate the basic characteristics of the wave motion. Sound propagation in the atmosphere, acoustic filters and resonators, and the attenuation of sound in rooms and ducts by acoustic treatment will be discussed. Fundamental measurement techniques and statistical parameters applicable to the description of noise will be presented.

Contact: Jules Bernard, The Univ. of Tennessee Space Institute, Tullahoma, TN 37388 - (615) 455-0631, Ext. 276.

APPLICATIONS OF TIME SERIES ANALYSIS

Dates: April 14-18, 1980

Place: Institute of Sound and Vibration Research, University of Southampton, UK

Objective: To provide a comprehensive treatment of time and frequency domain analysis methods for transient and stationary random signals summarizing essential theory and giving engineering applications. To present theories and some applications related to non-stationary processes, system identification and response of non-linear systems to stochastic excitation. To apply the theory to well conceived practical problems utilizing the computers in the Data Analysis Centre enabling participants to experience how new methods may be related to present day industrial requirements.

Contact: Dr. Joseph K. Hammond, Institute of Sound and Vibration Research, University of Southampton, Southampton, Hampshire, England, S09 5NH - 559122, Ext. 467.

THE SIXTH ANNUAL RELIABILITY TESTING INSTITUTE

Dates: April 14-18, 1980

Place: The University of Arizona, Tucson

Objective: To provide reliability engineers, product assurance engineers and managers and all other engineers and teachers with a working knowledge of analyzing component, equipment, and system performance and failure data to determine the distributions of their times to failure, their failure rates, their reliabilities and their confidence limits; small sample size, short duration, low cost tests, and methods of analyzing their results; accelerated testing; test planning; electrical overstress and electrostatic failure protection; Bayesian testing; suspended items testing, sequential testing; and others.

Contact: Dr. Dimitri Kececioglu, Aerospace and Mechanical Engineering Dept., The University of Arizona, Bldg. 16, Tucson, AZ 85721 - (602) 626-2495/626-3901/626-3054/626-1755.

MACHINERY VIBRATION ANALYSIS SEMINARS

Dates: May 6-7, 1980
Place: Cherry Hill, New Jersey
Dates: June 17-18, 1980
Place: Oak Brook, Illinois
Dates: July 9-10, 1980
Place: New Orleans, Louisiana
Dates: August 12-13, 1980
Place: Sheraton Inn-Newark Airport, NJ
Dates: October 1-2, 1980
Place: Houston, Texas
Dates: December 9-10, 1980
Place: Atlanta, Georgia

Objective: These two day seminars on machinery vibration analysis will be devoted to the diagnosis and correction of field vibration problems. The material is aimed at field engineers. The sessions will include lectures on the following topics: basic vibrations; critical speeds; resonance; torsional vibrations; instrumentation, including transducers, recorders, analyzers, and plotters; calibration; balancing and vibration control; identification of unbalance, misalignment, bent shafts, looseness, cavitation, and rubs; advanced diagnostic techniques; identification of

defects in gears and antifriction bearings by spectrum analysis; and correction of structural foundation problems.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254/654-2053.

JUNE

FINITE ELEMENT ANALYSIS

Dates: June 3-6, 1980
Place: Charlottesville, Virginia
Objective: This course is intended to combine an introduction to engineering finite element analysis with a survey of advanced applications. Topics to be covered include solid mechanics, fluid dynamics, and heat transfer. Many engineering examples will be given throughout the course to assist in understanding the material.

Contact: VIBCO Research Inc., P.O. Box 3307, University of Virginia Station, Charlottesville, VA 22903 - (804) 924-3982.

MACHINERY VIBRATIONS SEMINAR

Dates: June 24-26, 1980
Place: Mechanical Technology, Inc.
Latham, New York
Objective: To cover the basic aspects of rotor-bearing system dynamics. The course will provide a fundamental understanding of rotating machinery vibrations; an awareness of available tools and techniques for the analysis and diagnosis of rotor vibration problems; and an appreciation of how these techniques are applied to correct vibration problems. Technical personnel who will benefit most from this course are those concerned with the rotor dynamics evaluation of motors, pumps, turbines, compressors, gearing, shafting, couplings, and similar mechanical equipment. The attendee should possess an engineering degree with some understanding of mechanics of materials and vibration theory. Appropriate job functions include machinery designers; and plant, manufacturing, or service engineers.

Contact: Mr. Paul Babson, MTI, 968 Albany-Shaker Rd., Latham, NY 12110 - (518) 785-2371.

JULY

INTRODUCTION TO THE VIBRATION AND STRESS ANALYSIS OF PRESSURE ACTUATED VALVES FOR GAS COMPRESSORS USING FINITE ELEMENT METHODS

Dates: July 21-22, 1980
Place: Purdue University
Objective: The course content is general to many fluid machinery systems utilizing pressure actuated flexible valves, however, class examples will emphasize small, high-speed, refrigerant compressors. Interest is directed to the development of suitable mathematical models for the prediction of the dynamic motion of the flexible valve during the compressor cycle and the resultant stress field in the valve. Participants should be familiar with the mathematical simulation philosophy for compressors. Extension of the valve modeling to more detailed descriptions compatible with the general compressor simulation will be presented.

Contact: James F. Hamilton, Ray W. Herrick Laboratories, School of Mech. Engrg., Purdue University, West Lafayette, IN 47907.

SEPTEMBER

MODAL ANALYSIS

Dates: September 17-19, 1980
Place: Cleveland, Ohio
Objective: This seminar will provide information on new techniques for identifying dynamic structural weaknesses. The sessions include the use of state-of-the-art instrumentation and software for creating a dynamic structural model in the computer. Techniques will be demonstrated for mode shape calculation and animated displays, computation of mass, stiffness and damping values and modal manipulation methods.

Contact: Bob Kiefer, Spectral Dynamics, P.O. Box 671, San Diego, CA 92112 - (714) 268-7100.

OCTOBER

VIBRATION TESTING

Dates: October 6-9, 1980

Place: San Diego, California

Objective: Topics to be covered are: exciters, fixtures, transducers, test specifications and the latest computerized techniques for equalization, control, and protection. Subjects covered include dynamics and dynamic measurements of mechanical systems, vibration and shock specifications and data generation. Demonstrations are given of sine random and shock testing and of how test specifications are met.

Contact: Bob Kiefer, Spectral Dynamics, P.O. Box 671, San Diego, CA 92112 - (714) 268-7100.

NOVEMBER

MACHINERY VIBRATION IV

Dates: November 11-13, 1980

Place: Cherry Hill, New Jersey

Objective: Lectures and demonstrations on vibration measurement rotor dynamics and torsional vibration are scheduled. General sessions will serve as a review of the technology; included are the topics of machine measurements, modal vibration analysis, and vibration and noise. The rotor dynamics sessions will include: using finite element, transfer matrix, and nonlinear models; vibration control including isolation, damping, and balancing. The sessions on torsional vibration feature fundamentals, modeling measurement and data analysis, self-excited vibrations, isolation and damping, transient analysis, and design of machine systems.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254/654-2053.

NEWS BRIEFS

news on current and Future Shock and Vibration activities and events

NEW AMERICAN NATIONAL STANDARDS AVAILABLE

American National Standard Method for the Measurement and Rating of Noise Emitted by Computer and Business Equipment S1.29-1979

This standard defines uniform procedures for measuring and reporting the noise emissions of computer and business equipment. The sound power produced by the equipment is determined and reported by using the noise power emission level in bels. The A-weighted sound pressure level at the operator's position is also reported. The standard covers general methods for installing and mounting equipment, operation of the equipment during the tests and environmental conditions during the measurements. Procedures for identifying discrete frequency components and impulsive noise are also described.

American National Standard Guidelines for the Use of Sound Power Standards and for the Preparation of Noise Test Codes S1.30-1979

This standard introduces a series of six standards specifying various methods for determining the sound power levels of machines and equipment. When applying these six standards to sound measurements on specific machines, it is necessary to decide which one or more of these standards is most appropriate for the required precision for the particular class of machine or equipment and for the purpose of the test. It is also necessary to decide on specific details for mounting and operating the machine to be tested within the general principles stated in the standards. Guidelines for making these decisions are provided in this standard. These guidelines are essential for the proper application of these acoustical measurement standards and for the preparation of specific sound test codes for various types of machines and equipment.

American National Standard Precision Methods for the Determination of Sound Power Levels of Noise Sources in Anechoic and Hemi-anechoic Rooms S1.35-1979

This standard describes a precision method for determination of the sound power levels of noise sources in laboratory anechoic or hemi-anechoic rooms. The standard contains information on instrumentation, installation and operation of the source, methods for determination of the sound power level on the measurement surface, procedures for the calculation of sound power level, directivity index and directivity factor, and techniques that may be used to qualify the laboratory facilities used for the measurements.

For further information, please contact.

Standards Secretariat
Acoustical Society of America
335 East 45th Street
New York, New York 10017

FIFTH PURDUE COMPRESSOR TECHNOLOGY CONFERENCE

July 23-25, 1980
Purdue University

The goals of the compressor technology conference are: to assemble recognized authorities to present invited papers of immediate or general interest; to provide a forum for the presentation of applied papers on good current practice, and research papers on good future practice; to provide an atmosphere for the general exchange of engineering information, problems, and solutions; and to provide a proceedings of the conference as a continuing reference manual for compressor designers and users.

The emphasis of the conference will be on positive displacement compressors for refrigerant, air, and other gases.

For further information about the Fifth Purdue Compressor Technology Conference contact:

Professor Werner Soedel
Ray W. Herrick Laboratories
School of Mechanical Engineering
Purdue University
West Lafayette, Indiana 47907

THE STRUCTURAL MECHANICS SOFTWARE SERIES - VOLUME III

Edited by N. Perrone and W. Pilkey

Volume III of this series continues the basic task of reviewing and summarizing available programs for structural engineering. The critical reviews, written by leading authorities, cover a wide range of engineering interests. Thev will assist the reader in selecting the best programs for solving particular problems.

The reviews and summaries in Volume III cover the following areas: multipoint boundary value problems, bridge superstructures, nonlinear analysis, rotor dynamics, stiff differential equation systems, ship hull vibration analysis and design, piping systems, and fracture mechanics.

The volume includes, for the first time, reviews and assessments of computational mechanics technology. Articles discuss finite element mesh optimization and enrichment techniques, mixed methods analysis, and damping models. The library of programs that are available on nationwide commercial computer networks and which were documented in Volumes I and II is described. Surveys of user's groups and computerized information sources are also given.

This book is published by and available from the University Press of Virginia, P.O. Box 3608, University Station, Charlottesville, Virginia 22903, for $25 (Virginia residents must add 4% tax). Volumes I and II are also available for $25 each, from the same source.

ARMY SYMPOSIUM ON SOLID MECHANICS 1980, Designing for Extremes: Environment, Loading, and Structural Behavior

September 30-October 2, 1980
Cape Cod, Massachusetts

This solid mechanics symposium will focus on the structural design problems which result from extreme environmental conditions and/or extreme loadings. Topics to be covered are as follows:

Environment
extremes of temperature, moisture, radiation, and chemical agents

Loading
shock, large magnitude dynamic and hydrostatic

Structural Behavior
post buckling phenomena, fracture, high strain rate response, large deformations, penetration, shock wave propagation, thermal wave propagation, and nonlinear material response

In addition, a session of 10-minute work in progress presentations is planned for which extended abstracts will be due August 1, 1980.

Papers must originate from in-house or contract researchers or designers for the Army, Navy, Air Force or other Government Agencies. All papers must be unclassified, relevant to DoD mechanics problems and should address the design community. A "Prior Publication Statement" will be required along with each manuscript to insure that the substance of papers will not have been published elsewhere prior to the symposium.

Mail abstracts to Mr. R. Morrissey, DRXMR-T, Army Materials and Mechanics Research Center, Watertown, Massachusetts 02172.

For additional information call (617) 923-3744 or Autovon 955-3744.

ABSTRACTS FROM THE CURRENT LITERATURE

Copies of articles abstracted in the DIGEST are not available from the SVIC or the Vibration Institute (except those generated by either organization). Inquiries should be directed to library resources. Government reports can be obtained from the National Technical Information Service, Springfield, VA 22151, by citing the AD-, PB-, or N- number. Doctoral dissertations are available from University Microfilms (UM), 313 N. Fir St., Ann Arbor, MI; U.S. Patents from the Commissioner of Patents, Washington, D.C. 20231. Addresses following the authors' names in the citation refer only to the first author. The list of periodicals scanned by this journal is printed in issues 1, 6, and 12.

ABSTRACT CONTENTS

MECHANICAL SYSTEMS

effects of fluid film cavitation. The effect of the introduction of oil via single hole, axial groove, or circumferential groove oil inlets is also considered in the bearing model. The bearings are assumed to be rigidly mounted and perfectly aligned.

ROTATING MACHINES

(Also see Nos. 303, 304, 305, 306, 307, 309, 310)

80-211

Distortions, Rotating Stall and Mechanical Solicitations

J. Colpin
Inst. de Mecanique, Liege University, Belgium, In: AGARD, Stresses, Vibrations, Struc. Integration and Engr. Integrity (including Aeroelasticity and Flutter), 24 pp (Apr 1979)
N79-27177

Key Words: Compressors, Mathematical models, Aerodynamic loads, Rotor blades

A one stage axial flow compressor is studied aerodynamically and mechanically when operating with moldistributed inlet flow, i.e., inlet flow total pressure distortions and rotating stall. A theoretical model is presented which calculates the distortion propagation through the compressor stage. That enables the computation of the unsteady aerodynamic loading of the rotor blades. The theoretical results are successful compared with the measured flow fields. An experimental study defines the rotating stall characteristics of the compressor stage and relates the blades vibrations and stresses with the existence of a distortion and/or rotating stall cell.

80-212

Dynamic Response of a Rotating, Balanced, Flexible Shaft Supported by a Thermohydrodynamic Bearing System

M.M. Stroman
Ph.D. Thesis, Texas A&M University, 166 pp (1979)
UM 7919111

Key Words: Shafts, Flexible rotors, Journal bearings

A method is presented which allows the simulation of the transient and steady state response of a balanced, flexible shaft supported by a realistic thermohydrodynamic journal bearing system. The bearing model also includes the effects of axial and circumferential lubricant flow as well as the

80-213

A Tapered Beam Finite Element for Rotor Dynamics Analysis

K.E. Rouch and J.-S. Kao
Allis-Chalmers Corp., Milwaukee, WI 53201, J. Sound Vib., 66 (1), pp 119-140 (Sept 8, 1979) 10 figs, 6 tables, 17 refs

Key Words: Rotors, Beams, Variable cross section, Finite element technique

The stiffness, mass and gyroscopic matrices of a rotating beam element are developed, a cubic function being used for the transverse displacement. Shear deflection is included by use of end nodal variables of shear strain, along with transverse displacement and cross section rotation; rotatory inertia effects are included in the energy functional to provide a Timoshenko beam formulation. The gyroscopic effects for small perturbations are linearized as a skew symmetric damping matrix. The formulation is implemented by numerical integration for a linearly tapered circular beam. Numerical comparisons for three previously published beam models are included, with results presented for the case of forward and reverse precession to verify the gyroscopic effects. The utility of the element in a general program for rotor dynamics analysis is identified.

80-214

An Experimental Study of the Response of a Turbomachine Rotor to a Low Frequency Inlet Distortion

L.W. Hardin
Ph.D. Thesis, North Carolina State Univ. at Raleigh, 160 pp (1979)
UM 7923049

Key Words: Rotors, Turbomachinery, Experimental data, Aerodynamic loads

As part of a joint technical effort involving North Carolina State University and United Technologies Research Center, an experiment is conducted to measure the response of an isolated turbomachine rotor to a distortion in inlet axial velocity. A once-per-revolution sinusoidal variation in axial velocity with an amplitude of approximately twenty percent of the average axial velocity is generated by an upstream

screen. The response of the rotor is studied using pressure transducers and skin friction gages mounted on one of the rotor blades and a velocity probe at the rotor exit plane as well as with standard stationary frame pneumatic instrumentation.

80-215

Study in a Straight Cascade Wind Tunnel of Aeroelastic Instabilities in Compressors

E. Szechenyi, H. Loiseau, and B. Maquennenhan

Office National d'Etudes et de Recherches Aeronautiques, Paris, France, In: AGARD, Stresses, Vibrations, Struc. Integration and Engr. Integrity (including Aeroelasticity and Flutter), 13 pp (Apr 1979)

N79-27178

Key Words: Turbomachinery, Compressors, Stability, Flutter

The first tests in a straight cascade wind tunnel brought to light several kinds of flutter. The parametric study, of which the paper gives the first results, shows the influence of reduced frequency, incidence, pitch axis position and Mach number. A few results obtained in supersonic regime are also given.

80-216

The Effect of Intake Conditions on Supersonic Flutter in Turbofan Engines

D.G. Halliwell

Rolls-Royce Ltd., Derby, UK, In: AGARD, Stresses, Vibrations, Struc. Integration and Engr. Integrity (including Aeroelasticity and Flutter), 8 pp (Apr 1979)

N79-27175

Key Words: Fans, Turbofan engines, Aircraft engines, Flutter

The nature of supersonic flutter, to which high tip speed, front stage fans of modern aircraft turbofan engines are susceptible, is introduced. The effect of varying engine intake conditions of altitude, flight speed and ambient temperature are examined, and test data is compared with theory. Some important flight conditions for minimum flutter margins in typical civil and military applications are outlined. The effect of engine intake type is then covered with respect to the degree of pressure distortion presented to the fan. A tentative relationship is derived between this distortion and flutter onset speed.

80-217

Reliability of Steam Turbine Rotors: Summary Report

C.H. Wells

Southwest Research Inst., San Antonio, TX, Rept. No. EPRI Proj. 502, EPRI-NP-293-SY, 55 pp (Oct 1978)

N79-27519

Key Words: Rotors, Steam turbines, Life tests, Fracture properties

An automated Steam Turbine Rotor Analysis Program (STRAP) is developed to facilitate the prediction of rotor lifetime given the duty cycle of the turbine and the results of ultrasonic examination from the rotor bore. STRAP consists in part of a preprocessor code that generates the boundary conditions and finite-element mesh for transient and steady-state temperature and stress analyses, employing the ANSYS general-purpose structural analysis code.

80-218

Steam Turbine Rotor Reliability: Task Details

S.D. Brown, G.A. Clarke, T.S. Cook et al

Batelle Columbus Labs., Columbus, OH, Rept. No. EPRI Proj. 502, EPRI-NP-923, 551 pp (Nov 1978)

N79-27520

Key Words: Rotors, Steam turbines, Life tests, Fracture properties

The viability of a steam turbine rotor component lifetime prediction system that is based on finite element thermoelastic stress analysis and fracture mechanics, and that uses details of field NDE inspection results as input to the calculations is investigated. Tasks formed include lifetime prediction analysis system, nondestructive evaluation, destructive tests, and material mechanical properties measurements. The automated Steam Turbine Rotor Analysis Program (STRAP) is developed to facilitate the prediction of rotor lifetime given the duty cycle of the turbine and the results of ultrasonic examination from the rotor bore.

80-219

Dynamic Loading of Machine Spools - The Kinematics and Kinetics of Rotating Winding Processes (Dynamische Beanspruchungen von Maschinenspulen – Problematik der Kinematik und Kinetik rotierender Wickelvorgange)

P. Gummert

Institut f. Mechanik der TU Berlin, Berlin, Germany, Konstruktion, 31 (8), pp 301-307 (Aug 1979) 11 figs (In German)

Key Words: Cables (ropes), Rotors (machine elements), Spools

The kinematics and kinetics of winding processes of ropes and cables, as well as the dynamic loads on machine spools are investigated. The effects of winding geometry, as well as velocity and acceleration are considered. The dynamic loads on the drum are formulated analytically by means of gyroscopic couples and the resulting bearing loads, and calculated numerically using a typical spool as an example.

RECIPROCATING MACHINES

(Also see Nos. 298, 380)

80-220

Pump Modelling for Power System Stability Studies

B. Hacobian and H. Yee

School of Electrical Engrg., The Univ. of Sydney, Australia, Instn. Engr., Austral., E.E. Trans., EE15 (1), pp 17-21 (1979) 4 figs

Key Words: Pumps, Electric power plants, Stability

The aim of this study is to find a satisfactory way of modeling a pump in power system stability studies, and then to determine the significance of the effect of a pump load on machine operation. Three different pump load representations are considered, the simplest of which (constant torque) is commonly used in practice at present. Power system stability analyses are performed for both small and large disturbances.

80-221

Stability and Forced Torsional Vibrations of Speed Controlled Piston Engines (Stabilitatsverhalten und erzwungene Drehschwingungen drehzahlgeregelter Kolbenkraftmaschinenanlagen)

R. Kritzer

Motoren-Werke Mannheim AG, Konstruktion, 31 (9), pp 357-362 (Sept 1979) 4 figs, 11 refs (In German)

Key Words: Engines, Diesel engines, Velocity control, Torsional vibration

In this article a general method for testing the stability and for calculating the forced torsional vibrations of speed controlled piston engines is developed. The method is based on a torsional vibration system composed of an arbitrary number of masses.

POWER TRANSMISSION SYSTEMS

80-222

Driveline Failure Modes Characterized

Auto. Engr. (SAE), 87 (9), pp 28-30 (Sept 1979) 5 figs

Key Words: Driveline vibrations, Failure analysis

Interrelationship of driveline failure modes can sometimes obscure the original cause of failure. Interrelationships between structural overload failure, structural fatigue failure, and surface wear are discussed. The article is based on SAE Paper No. 790878.

ELECTROMECHANICAL SYSTEMS

(Also see No. 310)

80-223

Digital Simulation of the Dynamic Travel Characteristics of an Electric Lift

M.A. Parameswaran and R. Kalyanakrishnan

Computer Centre, Indian Inst. of Tech., Madras 600 036, India, Mech. Mach. Theory, 14 (5), pp 309-317 (1979) 7 figs, 5 refs

Key Words: Elevators, Vibration response, Digital simulation, Mathematical models, Computer programs

A representative vibration model for an electric lift is developed and analyzed. Equations are also derived for the rate

of change of the rope tensions assuming that the rope elasticity is inversely proportional to rope length. A Continuous System Modeling Program (CSMP) is written to simulate the lift operation in the computer. Results of a trial computer run for a typical lift which is accelerated down and suddenly stopped by application of the emergency safety clamp are given.

STRUCTURAL SYSTEMS

BRIDGES

80-224

Displacement Induced Fatigue Cracks

J.W. Fisher, T.A. Fisher, and C.N. Kostem

Fritz Engrg. Lab., Lehigh Univ., Bethlehem, PA 18015, Engrg. Struc., 1 (5), pp 252-257 (Oct 1979) 17 figs, 7 refs

Key Words: Bridges, Fatigue life, Moving loads

This paper examines two cases of fatigue cracking at short gap conditions. Strain measurements and a detailed analysis are used to demonstrate that such cracking results from the out-of-plane movements of the web in the short gap region.

80-225

Railway-Bridge Impact: Simplified Train and Bridge Model

K. Chu, V.K. Garg, and C.L. Dhar

Illinois Inst. of Tech., Chicago, IL, ASCE J. Struc. Div., 105 (ST9), pp 1823-1844 (Sept 1979) 12 figs, 5 tables, 17 refs

Key Words: Bridges, Moving loads, Railroad trains, Mathematical models, Interaction: vehicle-terrain

A lumped mass model of a railway bridge is developed where only the vertical degree-of-freedom for each joint is considered. The vehicle system is idealized as a three degree-of-freedom model of a railway vehicle consisting of the carbody and wheel-axle sets. Dynamic interaction equations for the bridge-vehicle system are derived and solved using the numerical integration method. Impact factors for member forces and nodal deflections are generated under the action of a single or a series of three moving vehicles. Impact factors are compared with AREA specifications for truss and girder bridges.

80-226

Dynamic Analysis of Cable-Hung Ruck-A-Chucky Bridge

Z. Lu

T.Y. Lin International, San Francisco, CA, ASCE J. Struc. Div., 105 (ST10), pp 2009-2018 (Oct 1979) 9 figs, 4 tables, 9 refs

Key Words: Bridges, Suspension bridges, Finite element technique, Seismic response, Aerodynamic response

The hanging-arc structure of the Ruck-A-Chucky Bridge is idealized for finite element analysis as a space assemblage of line elements with beam elements representing the girder and inclined axial elements representing the cables. Correctness of the analysis is verified by a shaking-table model. Test and analytical data of the model are compared. Seismic and aerodynamic responses of the two versions of the bridge, a steel and a concrete, as finally designed are presented.

BUILDINGS

80-227

Seismic Design of Low-Rise Steel Buildings

C.J. Montgomery and W.J. Hall

Univ. of Alberta, Edmonton, Alberta, Canada, ASCE J. Struc. Div., 105 (ST10), pp 1917-1933 (Oct 1979) 6 figs, 8 tables, 12 refs

Key Words: Buildings, Seismic design, Earthquake resistant structures

The behavior of selected low-rise steel buildings subjected to earthquake base motions is studied, and recommended techniques for the earthquake resistant design of low-rise buildings are presented. The seismic response of buildings of practical proportions when subjected to seismic excitation is determined using inelastic time-history analysis. Practical methods of analysis, specifically the modal method and the quasi-static building code (equivalent lateral force) approach, are evaluated for use in estimating seismic response.

80-228

Linear and Nonlinear Earthquake Responses of Simple Torsionally Coupled Systems

C.L. Kan and A.K. Chopra

Earthquake Engrg. Research Ctr., California Univ., Richmond, CA, Rept. No. UCB/EERC-79/03, NSF/RA-790122, 120 pp (Feb 1979)

PB-298 262/7GA

Key Words: Buildings, Earthquake response

The effects of torsional coupling on the earthquake response of simple one-story structures in both elastic and inelastic ranges of behavior are analyzed. The structures considered are symmetrical about one principal axis of resistance. Torsional coupling arising only from eccentricity between centers of mass and elastic resistance is considered. Systems with several resisting elements, columns and walls are idealized by a single-element model. Responses of such a model to a selected earthquake ground motion are presented for a wide range of the basic structural parameters.

80-229

Dynamic Tests of a Reinforced Concrete Building

T.V. Galambos and R.L. Mayes

Dept. of Civil Engrg., Washington Univ., St. Louis, MO, Rept. No. RR-51, NSF/RA-780215, 245 pp (June 1978)

PB-297 835/1GA

Key Words: Buildings, Reinforced concrete, Earthquake resistant structures, Dynamic tests

An eleven-story reinforced concrete building is subjected to many cycles of sinusoidal lateral loads. The structure and the equipment used for the tests are described. The tests ran for 138 days, and were divided into four phases: measurement of the dimensional and structured properties of the building; small amplitude shaking on the top floor to determine the original dynamic properties of the structure; large amplitude shaking on the top floor and acquisition of the resulting data; and analysis of the results.

80-230

Lessons from Dynamic Tests of an Eleven Storey Building

T.V. Galambos and R.C. Mayes

Dept. of Civil Engrg., Washington Univ., St. Louis, MO 63130, Engrg. Struc., 1 (5), pp 264-273 (Oct 1979) 17 figs, 6 tables, 7 refs

Key Words: Buildings, Multistory buildings, Reinforced concrete, Dynamic tests

Part of an eleven-story reinforced concrete building was made available for the dynamic tests prior to its final demolition. The purpose of this paper is to give a brief description of the tests and to discuss the significance of the test results.

80-231

Measurement and Analysis of Traffic-Induced Vibrations in Buildings

D.J. Martin, P.M. Nelson, and R.C. Hill

Transport and Road Research Lab., Crowthorne, UK, Rept. No. TRRL-SUPPLEMENTARY-402, 32 pp (1978)

PB-297 336/2GA

Key Words: Buildings, Traffic-induced vibrations, Traffic noise, Measurement techniques

Techniques are described for the measurement and analysis of ground-borne structural vibration and air-borne low frequency noise in buildings caused by road traffic. A measurement system comprising piezoelectric quartz crystal accelerometers and condenser microphones is used, and signals from these transducers are recorded on a magnetic tape recorder. Analysis of the recorded data is carried out using 1/3 octave frequency bands over the range from 3.15 to 500 Hz. Long term statistical averages and single vehicle peak event frequency spectra are obtained from measurements taken in a terraced property adjacent to a busy city road.

TOWERS

80-232

Environmental Loadings on Concrete Cooling Towers - Types, Likelihood, Effects and Consequences

P.L. Gould

Dept. of Civil Engrg., Washington Univ., St. Louis, MO 63130, Engrg. Struc., 1 (5), pp 258-263 (Oct 1979) 13 figs, 8 refs

Key Words: Cooling towers, Wind-induced excitation, Seismic excitation, Thermal excitation

The objectives of this paper are to describe some commonly encountered environmental loading conditions (thermal, wind and seismic); to examine the likelihood of each occurring; to characterize the predominant structural effects; and to point out some consequences for design.

FOUNDATIONS

(Also see Nos. 387, 389, 390, 391, 393)

80-233

Vibration Studies on Jolter Foundations

P. Srinivasulu, C.V. Vaidyanathan, N. Lakshmanan, and T.S. Thandavamoorthy

Structural Engrg. Research Ctr., Madras, India, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 907-918, 4 figs, 3 tables, 7 refs

Key Words: Foundations, Industrial facilities, Machine foundations, Vibrating foundations

The paper presents a study on existing jolter foundations in an industrial plant. A jolter is essentially an impact causing machine. The paper includes an explanation of the problem, mathematical model used for computation as well as measurements of vibration conducted at the site.

80-234

Compliance Function of Footing in Two-Layer Medium

M.M. Ettouney and A.K. Kar

Burns & Roe, Inc., Woodbury, Long Island, NY, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. I, pp 425-440, 6 figs, 21 refs

Key Words: Footings, Harmonic functions, Harmonic excitation

The paper presents a set of formulas to determine the complex swaying compliances for embedded rigid footings in a two-layer medium, excited by a harmonic forcing function. The bottom layer generally, though not necessarily, consists of rock. The top layer is with or without material damping. The results obtained by using the formulas are compared with "exact" solutions by the finite element and semi-analytical methods. Comparisons between the results of the suggested formulas and the "exact" solutions show excellent agreement for practical cases. Parametric studies are also made. They include the effects of material damping, depth of embedment, and relative shear wave velocities of the two layers.

80-235

Soil-Structure Interaction for Footing Foundations

A.W. Dawson

Woodward Clyde Consultants, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. I, pp 380-393, 6 figs, 14 refs

Key Words: Footings, Foundations, Interaction: soil-structure, Seismic response

One of the purposes of this paper is to illustrate a few of the ways in which footing foundations may play an important role in modifying structural behavior through soil-structure interaction, even when no obvious foundation failures occur. A number of criteria for evaluating the seismic behavior of footing foundations are presented. First, the ability of columns to transmit moments to footings is evaluated in terms of the relative stiffness of the column, foundation, and girder. The ultimate moment capacity of the footing and nonlinear soil behavior are considered in this evaluation; and a simple analytical procedure is presented. The implications of varying degrees of column base fixity are discussed in terms of structural behavior and geotechnical footing design criteria. In order to provide additional criteria for selecting design bearing pressures, the applicability of traditional bearing capacity equations to the case of seismic loadings is examined. Finally, the influence of both individual and group footing compliance is discussed so that the consideration of soil-structure interaction effects in the analysis of the seismic forces which act on structures may be extended to the case of footing foundations.

80-236

Dynamic Response of Block Foundations

P. Srinivasulu, N. Lakshmanan, T.S. Thandavamoorthy, and C.V. Vaidyanathan

Structural Engrg. Research Ctr., Madras, India, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 890-906, 4 figs, 3 tables, 17 refs

Key Words: Foundations, Modal analysis, Mathematical models

Modal analysis of block type foundations, including damping, and test data from vibration tests on surface and embedded footings are presented. An empirical relationship for predicting the damping at any particular frequency level is derived. Effect of surface roughness, embedment, backfill, etc., are briefly discussed. A simple mathematical model is presented to predict completely the response of coupled oscillations in block foundations.

80-237

Mathematical Modeling of Cyclic Soil Behavior

J.H. Prevost and T.J.R. Hughes

California Inst. of Tech., Pasadena, CA, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 746-761, 11 figs, 1 table, 12 refs

Key Words: Soils, Mathematical models, Interaction: structure-foundation, Off-shore structures

The proposed analytical model describes the anisotropic, elastoplastic, path-dependent stress-strain-strength properties of inviscid saturated soils subjected to complicated, and in particular, to cyclic loading paths. The formulation is general and incorporates both drained and undrained loading conditions. The model's extreme versatility and its accuracy are demonstrated by applying it to represent the undrained behavior of a particular clay under both monotonic and cyclic loading conditions. Thereafter, the model is used in a finite element formulation to analyze the interaction of an offshore gravity structure with its soil foundation when subjected to cyclic wave loading.

80-238

The Dynamic Response of Anisotropic Clay

A.S. Saada, G.F. Bianchini, and L.P. Shook

Case Western Reserve Univ., Cleveland, OH, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 777-801, 16 figs, 2 tables, 20 refs

Key Words: Clays, Soils, Dynamic tests, Anisotropy

The results of the experimental investigation described in this paper demonstrate the importance of the clay fabric and the influence it has on the dynamic behavior.

80-239

Constitutive Equation for Cyclic Behavior of Cohesive Soils

R.J. Krizek, A.M. Ansal, and Z.P. Bazant

Northwestern Univ., Evanston, IL, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. I, pp 557-568, 3 figs, 4 tables, 8 refs

Key Words: Soils, Cyclic loads, Constitutive equations, Earthquake response

Endochronic theory is employed to develop a relatively general constitutive relationship to model the dynamic behavior of cohesive soils subjected to multi-dimensional stress or strain paths. The proposed constitutive law is capable of describing strain softening and hardening; densification and dilatancy; frictional aspects; and rate dependence of the stress-strain behavior. The theory is based on a series of new internal state variables that are defined in terms of semi-empirical intrinsic material relationships.

80-240

Finite Element Analysis of Stress Propagation in a Clay

R.N. Yong and H. Lee

Geotechnical Research Ctr., McGill Univ., Montreal, Canada, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 1097-1110, 8 figs, 14 refs

Key Words: Soils, Clays, Finite element analysis, Pulse excitation

The dynamic properties of modulus of elasticity and viscosity of a clay soil under one-dimensional transient compressive pulse are evaluated with consideration of frequency effects using the finite element method. These properties, expressed as functions of frequency, are used for subsequent analyses of stress propagation using the normal mode method. One example problem is illustrated and the response is compared against the experimental result as well as the result without the consideration of frequency-dependency.

80-241

Liquefaction Potential at an Ocean Outfall in Puerto Rico

M.S. Nataraja, I.H. Wong, and J.V. Toto

Dames & Moore, Cranford, NJ, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 685-703, 9 figs, 21 refs

Key Words: Soils, Earthquake effects, Oceans, Water waves

This paper presents some of the soil dynamic considerations used in evaluating liquefaction potential beneath the four-foot diameter prestressed concrete pipe outfall.

80-242

Post-Cyclic Strength of Marine Limestone Soils

S.R. Prager and K.L. Lee

Fugro, Inc., Long Beach, CA, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 732-745, 7 figs, 3 tables, 11 refs

Key Words: Soils, Seismic response, Earthquake response

In order to determine the strength capable of being mobilized by cohesive marine limestone soils during earthquake loading, a testing program is designed to evaluate the static shear strength of these soils following cyclic loads. The residual static strengths are compared to the conventional strength static envelope to determine the loss of strength due to cyclic effects. Residual strengths are also compared to the induced earthquake stresses to indicate the capacity of the soils to resist the earthquake loading.

80-243

Compaction and Cyclic Shear-Strength of Granular Backfill

I.H. Wong, M.S. Abdelhamid, and J.A. Fischer

Dames & Moore, Cranford, NJ, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 1042-1055, 7 figs, 2 tables, 13 refs

Key Words: Soils, Soil compacting, Dynamic tests, Seismic design

This paper summarizes the index properties as well as the cyclic shear strength of laboratory compacted samples of the granular backfill material. In addition, it discusses the criteria utilized in selecting this material as a suitable structural backfill. Index properties investigated included grain size distribution, specific gravity, maximum and minimum densities, as well as moisture density relationships based on Modified Proctor compaction tests. The effect of "scalping" on the results of the compaction tests and cyclic strength tests is also discussed.

80-244

Shear Devices for Determining Dynamic Soil Properties

D.K. Wright, P.A. Gilbert, and A.S. Saada

Case Western Reserve Univ., Cleveland, OH, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 1056-1075, 15 figs, 22 refs

Key Words: Soils, Dynamic tests, Test equipment and instrumentation

This paper examines the state of the specimen in some of the more popular shearing devices used for dynamic (as well as for static) soil testing. The conditions prevailing in the hollow cylinders are briefly discussed and compared; the importance of the proper ratio between height and thickness and height and mean diameter is emphasized. A relatively detailed study of the simple shear devices of the Roscoe type and of the NGI type is made. The results of a three-dimensional photoelastic study based on the frozen stress technique are presented and compared to those obtained from published finite element analyses.

80-245

Measurement and Analysis of Train-Induced Ground Vibration

H.P. Verhas

Welvaartstraat 98, B-9300 Aalst, Belgium, Noise Control Engr., 13 (1), pp 28-41 (July/Aug 1979) 16 figs, 9 tables, 9 refs

Key Words: Ground vibration, Railroad trains, Measurement techniques

The techniques used in a review of the ground vibration measurements made at two sites on the British Railways' system are discussed and the recorded data are analyzed.

80-246
Analytical Procedures in Soil Dynamics
J. Lysmer
Earthquake Engrg. Research Ctr., California Univ., Richmond, CA, Rept. No. UCB/EERC-78/29, 101 pp (Dec 1978)
PB-298 445/8GA

Key Words: Soils, Dynamic analysis, Foundations, Pile structures, Interaction: soil-structure

The 1978 state-of-the-art of soil dynamics analysis is reviewed. A classification system is suggested for soil dynamics response problems and a discussion is given of our current ability and future possibilities for solving different types of problems. Special attention is given to the possibilities for nonlinear and effective stress analysis of seismic problems. Major topics discussed are: foundation vibrations, pile vibrations, seismic site response problems, and soil-structure interaction.

80-247
Stiffness and Damping of Piles in Layered Media
M. Novak and F. Aboul-Ella
The Univ. of Western Ontario, London, Canada N6A 5B9, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 704-719, 17 figs, 28 refs

Key Words: Pile structures, Damping coefficients, Stiffness coefficients

An approximate theory is presented that makes it possible to include variation of soil properties with depth in the calculation of dynamic stiffness and damping of piles. An extensive parametric study is presented to illuminate the effects of the soil profile, frequency, material damping, fr^ length of the pile and other factors. Dynamic stiffness .nd damping of embedded piles are given for the case of parabolic variation of soil stiffness with depth. Charts are presented for use in practical applications. Rigid bodies are also treated.

80-248
Simulation of Lateral Pile Behavior Under Earthquake Motion
H. Matlock, S.H.C. Foo, and L.M. Bryant
The Univ. of Texas at Austin, TX, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 600-619, 12 figs, 21 refs

Key Words: Off-shore structures, Pile structures, Earthquake response, Interaction: soil-structure, Mathematical models

The analysis presented is concerned with the behavior of a single pile, with particular emphasis on the soil-pile coupling. Simplified superstructure effects are considered, and separately determined free-field soil displacements are used as the input excitation. A discrete-element mechanical analogy is used to represent a pile under various loadings and restraints. The soil-pile coupling at each node is represented by a multi-element assemblage of friction blocks, springs, and dashpots which facilitate the development of hysteretic pile-soil interaction under earthquake loading.

80-249
Impedance Function of a Group of Vertical Piles
J.P. Wolf and G.A. von Arx
Electrowatt Engrg. Services Ltd., P.O. Box 8022, Zurich, Switzerland, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 1024-1041, 12 figs, 1 table, 12 refs

Key Words: Pile structures, Interaction: soil-structure, Seismic design, Nuclear reactors

Impedance and transfer functions of a group of vertical piles located in any desired configuration in plan in a horizontally stratified soil layer are derived. Hysteretic and radiation damping are accounted for. The method separates the piles and the soil, introducing unknown interaction forces. The total flexibility matrix of the soil is constructed, superposing the complex flexibility coefficients caused by the interaction forces of a single pile only. The dependence of the impedance and transfer functions on the oscillating frequency for foundations with different numbers of piles is investigated.

UNDERGROUND STRUCTURES

80-250
Seismic Vulnerability, Behavior and Design of Buried Pipelines, Final Report of Phase I Study (Seismic Vulnerability, Behavior and Design of Underground Piping Systems)

L.R. Wang, M.J. O'Rourke, and R.R. Pikul
Dept. of Civil Engrg., Rensselaer Polytechnic Inst., Troy, NY, Rept. No. NSF/RA-790093, 148 pp (Mar 1979)
PB-298 269/2GA

Key Words: Pipelines, Underground structures, Seismic response

The seismic damage and response behavior of general buried pipelines is presented and vulnerability evaluation and design criterion of buried simple piping systems are described. The investigation focuses on the "Simplified Analysis" and "Quasi-static Analysis" approaches for determining the axial strains and relative joint displacements/rotations due to seismic shaking. To verify the assumptions and limitations in the analyses, the ground motion characteristics of the San Fernando earthquake are studied in detail. To fulfill the analysis requirements, the related soil parameters are discussed. To evaluate the seismic vulnerability/design of simple buried piping systems, a seismic risk analysis using data for Albany, New York is performed, and a failure criterion for buried water pipes is proposed. Finally, a case study is performed for the Latham Water Distribution System using these procedures.

80-251
Failure of Underground Hardened Structures Subjected to Blast Loading
C.A. Ross and C.C. Schauble
Graduate Engrg. Center, Florida Univ., Eglin AFB, Rept. No. AFOSR-TR-79-0679, 197 pp (Apr 30, 1979)
AD-A069 896/9GA

Key Words: Underground structures, Hardened installations, Beams, Plates, Blast response

The major objective of this study is to apply plastic hinge response to buried reinforced concrete beams and plates. Using the plastic hinge response, of both stationary and moving hinges, equations of motion are derived for beams and plates using time and spatially varying loading functions. The spatial variations are evaluated in closed form and the time variations are evaluated numerically.

80-252
Earthquake Response of Buried Pipeline
M.J. O'Rourke and L.R.L. Wang
Rensselaer Polytechnic Inst., Troy, NY 12181, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 720-731, 6 figs, 22 refs

Key Words: Pipelines, Underground structures, Earthquake response

The purpose of this paper is to investigate two assumptions dealing with the relative motion between the pipe and the soil and also with the character of the seismic waves which form the basis for the presently available seismic design procedures for buried pipelines subjected to ground shaking.

HARBORS AND DAMS

(Also see No. 261)

80-253
Stochastic Seismic Stability Prediction of Earth Dams
M.P. Singh and T.P. Khatua
Structural Analytical Div., Sargent & Lundy, Chicago, IL, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 875-889, 6 figs, 2 tables, 12 refs

Key Words: Dams, Seismic response, Stochastic processes

A method, based on stochastic principles, is presented for seismic stability prediction of earth dams. The problem of nonlinearity due to strain dependent soil properties is solved through the stochastic linearization technique; the formulation for applying this technique to a finite element discretization of a dam is developed. The method is iterative and step-wise linear. The application of the method is demonstrated with an example of an earth dam.

80-254
Post-Earthquake Stability Analysis of Earth Dams
N. Ramanujam, L.L. Holish, and W.W.H. Chen
Geotechnical Div., Sargent & Lundy, Chicago, IL, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 762-776, 12 figs, 2 tables, 22 refs

Key Words: Dams, Seismic response

An approach to post-earthquake stability analysis of earth dams is presented. First, a finite element evaluation of the dynamic stresses induced within the dam as a result of the anticipated earthquake is determined. Then the residual undrained static shear strength after the earthquake is determined from the laboratory static triaxial tests on soil samples subjected to cyclic loading. The cyclic loading used corresponds to the dynamic shear stresses and the equivalent number of cycles induced in the critical element due to the anticipated earthquake. Finally, a limit equilibrium analysis is performed using the residual undrained static shear strength to evaluate the post-earthquake stability of the dam.

80-255

Drainage Effects on Seismic Stability of Rockfill Dams

K. Sadigh, I.M. Idriss, and R.R. Youngs
Woodward-Clyde Consultants, San Francisco, CA, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 802-818, 6 figs, 20 refs

Key Words: Dams, Seismic response

A simplified method is presented for incorporating the effect of drainage in seismic stability computations for rockfill dams. The method is intended to supplement the currently used dynamic analysis procedures which are primarily applicable to undrained field conditions. The effects of drainage are considered by making simplifying assumptions with regard to: dissipation of excess pore-water pressures within the embankment; and cyclic strength characteristics of embankment materials under partially-drained conditions.

80-256

Analysis of Chabot Dam During the 1906 Earthquake

F.I. Makdisi, H.B. Seed, and I.M. Idriss
Woodward-Clyde Consultants, San Francisco, CA, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 569-587, 11 figs, 4 tables, 24 refs

Key Words: Dams, Earthquake response

This paper examines the applicability of the dynamic analysis procedure by evaluating the behavior of a dam that did not suffer any serious damage under conditions of strong ground motions (similar to those occurring during the 1906 earthquake) using the results of an extensive field and laboratory testing program. The resulting element strain potentials are computed and an approximate finite element procedure is used to integrate these strain potentials into an overall embankment deformation pattern.

80-257

Effect of Load Form and Sample Reconstitution on Test Results

W.F. Marcuson, W.D. Dennis, Jr., L.A. Cooley, and R.C. Horz
Soils and Pavements Lab., U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 588-599, 7 figs, 1 table, 6 refs

Key Words: Dams, Earthquake response, Experimental data

This paper presents the results of dynamic laboratory tests performed on undisturbed and reconstituted samples of hydraulic fill dams located in seismically active areas. The undisturbed samples are taken with a Hvorslev fixed piston sampler. A number of the samples are drained and frozen prior to transporting to the laboratory; the remaining samples are drained and tapped prior to transporting. Isotropically and anisotropically consolidated cyclic triaxial tests are performed on undisturbed and reconstituted samples of the shell and foundation material. Cyclic triaxial tests are also performed on undisturbed samples of the core material. A special series of cyclic triaxial tests is conducted to evaluate the influence of square and sine wave loading, and specimen reconstitution.

80-258

Cyclic Pore Pressures Under Anisotropic Conditions

W.D.L. Finn, K.W. Lee, C.H. Maartman, and R. Lo
Univ. of British Columbia, Vancouver, B.C., Canada, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. I, pp 457-471, 10 figs, 6 refs

Key Words: Dams, Earthquake response

A significant factor in seismic stability studies of slopes and dams of cohesionless materials is the development of

pore-water pressures under the complicated stress conditions acting on potential failure surfaces during an earthquake. The stress conditions are represented by consolidation under anisotropic stress conditions, static shear stresses on potential failure planes and cyclic stresses representative of the earthquake loading.

80-259

Simplified Seismic Analysis for Tailings Dams

E.J. Klohn, C.H. Maartman, R.C.Y. Lo, and W.D.L. Finn

Klohn Leonoff Consultants Ltd., Vancouver, B.C. Canada, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. I, pp 540-556, 7 figs, 14 refs

Key Words: Dams, Earthquake response, Sand

This paper presents a method for approximating the increases in pore pressures that might be expected within a dam or embankment during an earthquake, with particular reference to sand-fill tailings dams. Characteristics of sand-fill tailings dams that are significant to the liquefaction phenomenon are described. Detailed steps are presented for using the method in conjunction with a conventional pseudo-static form of stability analysis. Attention is given to suddenly-applied, undrained shear loadings within a tailings dam occasioned by sudden liquefaction of the tailings in the pond at the outset of the earthquake. The principal approximations entailed in the method are discussed.

80-260

Simplified Determination of Dynamic Stresses in Earth Dams

J.L. Vrymoed and E.R. Calzascia

Div. of Safety of Dams, Dept. of Water Resources, State of California, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 991-1006, 10 figs, 1 table, 7 refs

Key Words: Dams, Earthquake response, Finite element technique, Shear wave propagation technique

Analyses of earth dams are made to determine the stability during earthquake loading. The analyses are complex and costly, generally entailing field and laboratory investigations and static and dynamic finite element analyses. A study which compares the dynamic induced shear stresses computed by dynamic finite element techniques to a simplified analysis using a shear wave propagation technique is performed.

80-261

Aseismic Design of Offshore Platforms

V.V. Damodaran Nair

Offshore Structures Dept., Brown & Root, Inc., Houston, TX, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 660-684, 10 figs, 3 tables, 25 refs

Key Words: Off-shore structures, Seismic design, Interaction: structure-fluid, Interaction: soil-structure

A state-of-the-art procedure for the earthquake resistant design of offshore platforms is presented. The interaction of the soil-pile system with the platform and the effects of water-structure interaction are discussed. Engineering procedures to account for the above effects in design are also reviewed. Concepts and guidelines for the design of offshore platforms are presented. Procedures to develop structural and foundation configurations as well as factors to be considered in the selection of preliminary member sizes are discussed. The parameters which will have a major influence on the platform dynamic behavior are identified and their possible effects discussed.

ROADS AND TRACKS

80-262

Dynamic Models of a Railroad Track System

B. Prasad and V.K. Garg

Dynamic Research Div., Assn. of American Railroads, 3140 S. Federal St., Chicago, IL 60616, Appl. Math. Modeling, 3 (5), pp 359-366 (Oct 1979) 4 figs, 6 tables, 31 refs

Key Words: Railroad tracks, Mathematical models, Interaction: rail-wheel

A continuum model with microstructure is presented for a railroad track system. The track is represented as a laminated structure with two layers continuously supported by springs and dampers. Solutions for deflections of the track system subjected to a moving wheel load are obtained in a close

form using complex Fourier transforms for both damped and undamped foundations. Comparisons are made with the results obtained from quasi-static models of the track. Results of the model are compared with experimental data in limiting cases. Critical velocities are calculated for the track system with conventional rails. The influence of foundation modulus on critical velocity is analyzed in some detail. The results of this study agree well with those obtained using the continuum model with microstructure.

CONSTRUCTION EQUIPMENT

(Also see No. 223)

80-263

Dynamics of Vibratory-Roller Compaction

T. Yoo and E.T. Selig

Daewoo Engrg. Co., Seoul, Korea, ASCE J. Geotech. Engr. Div., 105 (GT10), pp 1211-1231 (Oct 1979) 11 figs, 2 tables, 29 refs

Key Words: Compaction equipment, Vibrators (machinery), Interaction: soil-structure, Mathematical models

The dynamic response of vibratory rollers during compaction is examined. A two-degree-of-freedom model is established for analytical representation of the soil-roller interaction. The characteristic responses of the vibratory roller are presented using the model. To check the validity of the theory, a series of full-scale field experiments is conducted. The experimental results agree well with the theoretical predictions. The understanding of basic vibratory-roller behavior derived from this study provides a basis for understanding the fundamental principles of vibratory-roller compaction.

POWER PLANTS

(Also see No. 220)

80-264

Nonlinear Structural Dynamic Analysis Procedures for Category I Structures

309 pp (July 1979)
NUREG/CR-0948

Key Words: Nuclear power plants, Earthquake resistant structures, Dynamic structural analysis

This report presents the results of studies conducted to identify and recommend a simplified dynamic analysis procedure applicable for performing nonlinear analyses of Category I nuclear power plant structures. For the recommended simplified procedures, the theoretical background, mathematical formulation, analytical solution, verification of reliability, and interpretation of results are established. In addition, studies are conducted to compare the results of conventional linear analysis with nonlinear analyses to establish the relative merits of the two approaches.

80-265

Application of Frequency Domain Analysis to Transient Response of Nuclear Containment Structures

A.K. Sinha and S.K. Chaudhuri

Cherry Hill Operations Ctr., Stone & Webster Engrg. Corp., Cherry Hill, NJ 08304, Nucl. Engr. Des., 54 (1), pp 149-156 (Sept 1979) 9 figs, 6 refs

Key Words: Nuclear power plants, Containment structures, Frequency domain method, Time domain method, Interaction: soil-structure

A combination of frequency domain and time domain analyses is proposed to obtain the dynamic responses of nuclear power plant containment structures. A soil-structure model of a boiling water reactor containment subjected to an assumed safety relief valve blowdown load is used as illustration. Linear time-invariant systems are analyzed using input forcing functions with varying frequency contents. Time domain analysis is performed using a synthesized input forcing function. The system characteristic function is generated in the frequency domain through Fourier transforms of the response time history and the synthesized input time history. The frequency response due to any other forcing function is obtained in frequency domain by using the system characteristic function, and the response time history is obtained by inverse Fourier transforms of the frequency response. The results obtained by the proposed method are in close agreement with the conventional time domain dynamic finite element analysis.

80-266

Dynamic Loading of the Structural Wall in a Lithium-Fall Fusion Reactor

L.A. Glenn and D.A. Young

Lawrence Livermore Lab., Univ. of California, P.O. Box 808, Livermore, CA 94550, Nucl. Engr. Des., 54 (1), pp 1-16 (Sept 1979)

Key Words: Walls, Nuclear reactors

A simple model of a lithium-fall ICF reactor is formulated and the fall disassembly and the subsequent fluid-wall interaction resulting from the energy deposition by a laser-imploded fusion pellet is calculated. Two potential mechanisms for wall damage are identified: surface erosion and hoop failure.

80-267
On-Line Parameter Identification for Power System Transient Stability Augmentation
J. Lequarre
Ph.D. Thesis, Wayne State Univ., 184 pp (1979)
UM 7921686

Key Words: Electric power plants, Mathematical models, Parameter identification technique

The object of this dissertation is to study techniques to improve the transient stability of bulk interconnected Power Systems. In this dissertation, a crude external model is replaced by a model including some dynamics. A one-machine equivalent is proposed. The dissertation explores the behavior of a system composed of the local subsystem connected to one external machine. Useful conclusions are drawn about the simplifications allowed in the expressions needed for the new control algorithms. Several identification methods are then tested to determine which is best suited to the identification of the external parameters.

VEHICLE SYSTEMS

GROUND VEHICLES

(Also see Nos. 222, 245)

80-268
DPMAS Utilization Vehicle Parameter Identification
F.J. Kern and K.R. Dunipace
Missouri Univ., Rolla, MO, Rept. No. DOT-HS-804 721, 87 pp (Nov 1978)
PB-297 492/1GA

Key Words: Automobiles, Computerized simulation, Stability, Parameter identification technique

The Driver Performance Measurement and Analysis System (DPMAS) is a sophisticated instrumented vehicle developed by the National Highway Traffic Safety Administration for use in driver performance research. The project is directed at evaluating the DPMAS by using it to support the development and validation of a simplified model of lateral dynamics of automobiles. In this study, a method is shown for estimation of the transfer function coefficients for the second order model from data taken from the DPMAS.

80-269
Occupant-vs-Airbag Forces Measured
J.D. Horsch and C.C. Culver
Biomedical Science Dept., General Motors Corp., Auto. Engr. (SAE), 87 (10), pp 67-69 (Oct 1979) 5 figs

Key Words: Air bags (safety restraint systems), Collision research (automotive)

Researchers at General Motors have conducted a study on driver surrogate interactions with an inflatable steering wheel mounted air cushion. Static and dynamic tests were performed to demonstrate interaction forces between driver and air cushion restraint systems (ACRS).

80-270
Passive Restraints for Automobile Occupants - A Closer Look
Community and Economic Development Div., General Accounting Office, Washington, D.C., Rept. No. CED-79-93, 136 pp (July 27, 1979)
PB-298 320/3GA

Key Words: Collision research (automotive), Safety restraint systems, Seat belts, Automobile seat belts, Air bags (safety restraint systems)

Passive restraints for front-seat occupants will be required in all cars after September 1, 1983. Either an air bag or an automatic seat belt, the two prominent systems being considered, will serve this function. A solid chemical, sodium azide, will be used to generate the gas to inflate the air bag. These systems offer life-saving and injury-prevention potential; however, the Department of Transportation's quantification of the benefits lends a degree of certainty not fully supported by the test data.

80-271
Track Dynamics Program
H.C. Meacham, Jr., J.C. Swain, J.P. Wilcox, and G.R. Doyle
Batelle Columbus Labs., OH, Rept. No. TARADCOM-TR-12397, 207 pp (Oct 1978)
AD-A069 519/7GA

Key Words: Tracked vehicles, Tanks (combat vehicles), Off-highway vehicles, Computerized simulation

A comprehensive study of track/track dynamics is undertaken, utilizing analytical, laboratory test, and field test techniques to develop a better understanding of track dynamics and performance. Analytical techniques are developed to predict track vibration modes, chordal action effects, dynamic tension and path, energy dissipation, tension going over obstacles, tension distribution, pin/bushing stresses and deflections, temperature buildup, and end connector tightening effectiveness. Double-pin track for heavy tanks is analyzed with these techniques, and designs for improved track suitable for the XM-1 tank are developed.

80-272
Comparative Study of the Linear and Non-Linear Locomotive Response
E.H. Chang, V.K. Garg, C.H. Goodspeed, and S.P. Singh
Dynalectron Corp., Transportation Test Ctr., Pueblo, CO, J. Dyn. Syst., Meas. and Control, Trans. ASME, 101 (3), pp 263-271 (Sept 1979) 11 figs, 1 table, 12 refs

Key Words: Locomotives, Mathematical models, Transient response, Steady-state response, Railroad tracks, Suspension systems (vehicles)

A mathematical model for a six-axle locomotive is developed to investigate its dynamic response on tangent track due to vertical and/or lateral track irregularities. The model represents the locomotive as a system of thirty-nine degrees of freedom. The nonlinearities considered in the model are primarily associated with stiffness and damping characteristics of the primary suspension system. The transient and steady-state responses of the locomotive are obtained for the linear and nonlinear primary suspension systems. The response time-histories of the locomotive obtained by integrating the generalized equations of motion are presented. The potential uses of the model are indicated for studying the influence of different design parameters and predicting subsequent dynamic response.

80-273
Railroad Retarder Noise Reduction: Study of Acoustical Barrier Configurations
J.A. Morgan and U. Ingard
Burlington Northern, Inc., St. Paul, MN, Rept. No. DOT-TSC-NHTSA-79-35, DOT-HS-804 354, 93 pp (May 1979)
PB-297 502/7GA

Key Words: Railroad trains, Noise barriers, Noise measurement

Field measurements of noise were made near a railroad retarder system without barriers and with acoustical barriers of various configurations. The configurations tested included acoustically reflective and acoustically absorptive barriers with heights of 4 to 12 feet and lengths extending from 0 to 22 feet beyond retarder entrance and exit. Two of the 12 foot high barriers were also tested with a 1 foot inward projecting acoustical panel lip along the top.

80-274
Equivalent Mean Energy Level from Relatively Short Parts of Railway Lines
M. Louden
Ingenieur-Geologisches Institut, D-8821, Westheim, Germany, J. Sound Vib., 66 (1), pp 69-73 (Sept 8, 1979) 6 figs, 6 refs

Key Words: Railroad trains, Noise prediction, Mathematical models, Computer programs

A modified model of train noise is presented. Computer noise profiles of travelling trains are developed through a digital computer program based on this model and compared with experimental results. A method is given to predict the equivalent mean energy level L_{eq} from relatively short parts of railway lines.

80-275
Steering and Stability of Unsymmetric Articulated Railway Vehicles
A.H. Wickens
British Rail Research and Development Div., Derby, UK, J. Dyn. Syst., Meas. and Control, Trans. ASME, 101 (3), pp 256-262 (Sept 1979) 4 figs, 9 refs

Key Words: Articulated vehicles, Railroad trains, Railroad cars, Stability

A general theory is developed which shows that any articulated, unsymmetric vehicle, which lacks elastic members in the interconnections between wheelsets, can be made stable for running in one direction only.

80-276

Aerodynamic Noise Generated by High-Speed Trains

W.F. King, III and D. Bechert
DFVLR Berlin, Muller-Breslau-Strasse 8, 1000 Berlin 12, Federal Rep. of Germany, Noise Control Engr., 13 (1), pp 13-22 (July/Aug 1979) 12 figs, 2 tables, 15 refs

Key Words: Railroad trains, High speed transportation systems, Aerodynamic noise, Noise generation, Noise prediction

This paper briefly reviews theoretical and semi-empirical methods for predicting railway aerodynamic noise levels, and describes a semi-empirical formula based on the Peters equation for predicting peak pass-by wheel/rail noise levels. The experimental arrangement used in the present investigation of railway radiated noise is also described, and results of the measurements relevant to aerodynamically generated noise are discussed.

80-277

Noise Rating Criteria for Elevated Rapid Transit Structures

T.J. Schultz
Bolt Beranek and Newman, Inc., Cambridge, MA, Rept. No DOT-TSC-UMTA-79-25, UMTA-MA-06-0099-79-3, 146 pp (May 1979)
PB-297 419/4GA

Key Words: Rapid transit railways, Elevated railroads, Noise reduction

The purpose of this report is to recommend criteria for rating the noise radiated from elevated rapid transit structures during train passages, so that different types of structures can be inter-compared with respect to their noise impact on the immediate neighborhood, or alternatively, so that noise abatement programs for elevated structures may be developed on a rational basis. The report also summarizes information that is applicable to the rating of rail transportation noise in general. The report examines the requirements for descriptors that would be suitable for rating elevated structure noise and reviews existing noise ratings.

80-278

A Dynamics Simulation for a High Speed Magnetically Levitated Guided Ground Vehicle

D.B. Cherchas
Dept. of Mech. Engrg., Univ. of Toronto, Toronto, Ontario, Canada M5S 1A4, J. Dyn. Syst., Meas. and Control, Trans. ASME, 101 (3), pp 223-229 (Sept 1979) 8 figs, 18 refs

Key Words: High speed transportation, Ground effect machines, Interaction: vehicle-guideway, Computer programs, Mathematical models

An analysis and digital computer program are developed to simulate vehicle and guideway dynamic response. The magnetic levitation is of the electrodynamic suspension type. The mathematical model includes effects of the following: vehicle and guideway flexible deformations, vehicle suspension and propulsion pod translation relative to the vehicle, multiple guideway spans and aerodynamic loading. Illustrative results of the simulation are presented.

80-279

Controlled Dynamic Characteristics of Ferromagnetic Vehicle Suspensions Providing Simultaneous Lift and Guidance

D.A. Limbert, H.H. Richardson, and D.N. Wormley
Arizona State Univ., Tempe, AZ 85281, J. Dyn. Syst., Meas. and Control, Trans. ASME, 101 (3), pp 271-222 (Sept 1979) 7 figs, 10 refs

Key Words: Ground effect machines, Magnetic vehicle suspensions, Mathematical models, Dynamic properties

Static and dynamic analytical models are derived for an attractive ferromagnetic vehicle suspension. The suspension consists of a pair of laterally offset electromagnets, reacting with an inverted U-shaped iron rail, which are controlled using the sum and difference of the magnet pair currents to achieve simultaneous lift and guidance. The control currents are generated from relative gap displacement and absolute vehicle velocity and acceleration signals through an algorithm which yields minimal heave-sway coupling. The analytical models have compared favorably with experimental data from a small scale heave-sway motion test facility.

80-280

A Comparative Study of the Ride Quality of Tracked Ram Air Cushion Vehicle (TRACV) Suspension Alternatives

R.A. Luhrs, L.M. Sweet, and H.C. Curtiss, Jr.
Dept. of Mech. and Aerospace Engrg., Princeton Univ., NJ, Rept. No. DOT-TSC-RSPA-78-23, 132 pp (June 1979)
PB-297 840/1GA

Key Words: Ground effect machines, Suspension systems (vehicles), Active isolation, Mathematical models, Ride dynamics

A linearized model of the pitch-heave dynamics of a Tracked Ram Air Cushion Vehicle is presented. This model is based on aerodynamic theory which has been verified by wind tunnel and towed model experiments. The ride qualities and dynamic motions of the rigid vehicle moving over a guideway described by roughness characteristics typical of highways is examined in terms of the rms values of the vertical acceleration in the foremost and rearmost seats in the passenger cabin and the gap variations at the leading and trailing edges of the vehicle.

80-281

Road Surface Description and Vehicle Response

J.D. Robson
Dept. of Mech. Engrg., Univ. of Glasgow, UK, Intl. J. Vehicle Des., 1 (1), pp 25-35 (Oct 1979) 7 figs, 1 table, 4 refs

Key Words: Interaction: vehicle-terrain, Road roughness

The paper is concerned with the determination of vehicle response due to traversal of a road surface described by means of the concepts of random process theory. The relevant response theory is developed, first, in terms of a four-variate excitation and then in terms of the possible simplifying assumptions. The relationship between excitation and the road profile is explained. Roads are described in terms of single profiles, profile pairs and then, using the concept of isotropy, complete surfaces. The validity of the isotropic hypothesis is considered.

80-282

Laboratory Evaluation of Concrete Ties and Fastenings for Transit Use

A.N. Hanna
Construction Technology Labs., Portland Cement Assn., Skokie, IL, Rept. No. DOT-TSC-UMTA-79-24, UMTA-MA-06-0100-79-8, 79 pp (Mar 1979)
PB-297 533/2GA

Key Words: Railroad tracks, Measurement techniques, Measuring instruments, Dynamic structural analysis

This report was prepared as part of an ongoing research effort by the Urban Mass Transportation Administration (UMTA) to develop standard concrete ties for rapid transit use. The overall objective of this contract was to fabricate and evaluate, by laboratory tests, standard ties of different designs intended for transit use.

80-283

Measurement Program for Evaluation of Concrete Ties and Fastenings in Transit Track

A.N. Hanna
Construction Technology Labs., Portland Cement Assn., Skokie, IL, Rept. No. DOT-TSC-UMTA-79-18, UMTA-MA-06-0100-79-2, 42 pp (Mar 1979)
PB-297 570/4GA

Key Words: Railroad tracks, Measurement techniques, Measuring instruments, Dynamic structural analysis

This report outlines a measurement program to obtain data on the performance of standard tie designs and associated fastening systems under field service conditions. In addition, the program identifies limited data to be obtained from a wood tie track for comparison. Recommendations are presented for a measurement program for monitoring, over an extended duration, the performance of different cross tie track systems under typical transit conditions. The following topics are discussed: type of data to be collected; type of instrumentation to be installed; type of equipment required for data acquisition; test schedule; and criteria for evaluating test data. The recommendations presented in this report are applicable to wood and concrete cross-tie track systems.

80-284

Nonlinear Wheelset Forces in Flange Contact. Part 1: Steady State Analysis and Numerical Results

L.M. Sweet and J.A. Sivak
Dept. of Mech. and Aerospace Engrg., Princeton Univ., Princeton, NJ 08540, J. Dyn. Syst., Meas. and Control, Trans. ASME, 101 (3), pp 238-246 (Sept 1979) 9 figs, 17 refs

Key Words: Wheelsets, Interaction: rail-wheel, Mathematical models, Periodic response, Numerical analysis

A theoretical model for steady-state wheelset force/displacement relations in tread and flange contact is presented. The analysis includes nonlinear geometric constraints that characterize wheel/rail contact, creep forces in the contact plane due to wheel/rail differential velocities, limits on adhesion at each contact point, and equilibrium conditions applied to the wheelset body forces. The results of this analysis are important to the analysis of wheelset response to track inputs, curving performance, and wheelclimb derailment.

80-285

Nonlinear Wheelset Forces in Flange Contact, Part 2: Measurements Using Dynamically Scaled Models

L.M. Sweet, J.A. Sivak, and W.F. Putman
Dept. of Mech. and Aerospace Engrg., Princeton Univ., Princeton, NJ 08540, J. Dyn. Syst., Meas. and Control, Trans. ASME, 101 (3), pp 247-255 (Sept 1979) 11 figs, 2 tables, 17 refs

Key Words: Wheelsets, Railroad cars, Test models, Testing techniques, Interaction: rail-wheel

This paper presents new experimental methods for the study of rail vehicle dynamics through the use of scaled models on tangent track, and the application of these techniques to the measurement of nonlinear wheelset force/displacement relations in steady-state. These relations are important to the analysis of wheelset response to track inputs, curving performance of trucks, and wheelclimb derailment. A one-fifth scale model instrumented wheelset with new wheel profiles is used. Data are presented for wheelset lateral force and yaw moment for the nonlinear range of wheelset lateral displacements and yaw angles, including flange contact.

80-286

Nonlinear Analysis of Rail Vehicle Forced Lateral Response and Stability

J.K. Hedrick and A.V. Arslan
Dept. of Mech. Engrg., M.I.T., Cambridge, MA 02139, J. Dyn. Syst., Meas. and Control, Trans. ASME, 101 (3), pp 230-237 (Sept 1979) 12 figs, 27 refs

Key Words: Railroad cars, Statistical linearization, Interaction: rail-wheel

The method of statistical linearization is presented as a design tool for rail vehicles that is capable of including fundamental nonlinearities such as wheel profile geometry and suspension nonlinearities. The method is capable of predicting the response of the vehicle to statistical track irregularities as well as the onset of hunting. The fundamentals of the method, an efficient frequency domain numerical algorithm for stationary response, and a design example are presented. The design example illustrates the influence of wheel profile, gage, track roughness, and suspension variations on vehicle response and stability.

AIRCRAFT

(Also see No. 300)

80-287

A Suggestion as to a General Derivation of the Equations of Motion of a Deformable Aircraft for Small Perturbations Which Will be Most Generally Acceptable

D.L. Woodcock
Royal Aircraft Establishment, Farnborough, UK, Rept. No. RAE-TR-79011, DRIC-BR-67657, 53 pp (Jan 1979)
AD-A069 793/8GA

Key Words: Aircraft, Equations of motion

A general derivation of the equations of motion of a deformable aircraft for small perturbations is offered. The deformations are represented by an expression which is precisely linear in the generalized coordinates. Lagrange's equation for an arbitrary non-inertial frame is used, along with the principles of momentum.

80-288

Supersonic Unstalled Flutter

J.J. Adamczyk, M.E. Goldstein, and M.J. Hartmann
NASA Lewis Research Center, Cleveland, OH, In: AGARD, Stresses, Vibrations, Struc. Integration and Engr. Integrity (including Aeroelasticity and Flutter), 14 pp (Apr 1979)
N79-27181

Key Words: Flutter, Aircraft

A parametric study to show the effects of cascade geometry, inlet Mach number, and backpressure on the onset of single

and multi degree of freedom unstalled supersonic flutter is presented. Several of the results are correlated against experimental qualitative observation to validate the models.

80-289

The Equations of Motion of an Aircraft Embracing its Whole-Body and Deformational Degrees of Freedom

C.H.E. Warren

Royal Aircraft Establishment, Farnborough, UK, Rept. No. RAE-TR-79010, DRIC-BR-67362, 57 pp (Jan 15, 1979)

AD-A069 784/7GA

Key Words: Aircraft, Equations of motion

This report is intended as a contribution to the problem of unifying and relating the approaches adopted by the flight dynamicist who makes small perturbation studies of the behavior of an aircraft in, primarily, its whole-body degrees of freedom, and by the structural dynamicist who makes similar studies of the behavior in its deformational degrees of freedom. The report outlines a framework for a common approach. It goes as far as deriving the equations of motion, and showing how the terms in these equations relate to those traditionally used by the flight dynamicist and structural dynamicist.

80-290

Computation of Minimum Noise Aircraft Landing Trajectories

G. Cook

Virginia Univ., Charlottesville, VA, Rept. No. NASA-CR-158931, 75 pp (June 1978)

N79-27929

Key Words: Aircraft noise, Noise reduction

Efforts to reduce aircraft noise perceived by residents during landing are reported. Steps in the development of the aircraft aerodynamic model, noise model, population model, performance index, and optimization procedure are reviewed. The optimal trajectories from the three main near-terminal entry points are presented via tables and graphs.

80-291

Evaluation of F-111 Weapon Bay Aero-Acoustic and Weapon Separation Improvement Techniques

R.L. Clark

Air Force Flight Dynamics Lab., Wright-Patterson AFB, OH, Rept. No. AFFDL-TR-79-3003, 149 pp (Feb 1979)

AD-A070 253/0GA

Key Words: Aircraft, Aerodynamic noise, Noise reduction

Several aero-acoustic suppression devices have been evaluated which were considered feasible for installation on an F-111 aircraft for flight test evaluation. The most promising modification consists of a saw tooth spoiler mounted at the leading edge of the weapon bay. This device would be erected to a 90 degree position during the bay doors opening sequence. The spoiler is folded flush with the fuselage during all other flight conditions.

80-292

Dynamic Pressure Loads in the Air Induction System of the Tornado Fighter Aircraft

K.W. Lotter and N.C. Bissinger

Military Airplane Div., Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany, In: AGARD, Stresses, Vibrations, Struc. Integration and Engr. Integrity (including Aeroelasticity and Flutter), 20 pp (Apr 1979)

N79-27168

Key Words: Aircraft, Dynamic tests, Experimental data

The engine fact, duct and forward intake peak pressures applied for structural design of the European fighter airplane, Tornado, and the experimental data obtained during the development phase from full scale intake/engine compatibility test are described.

80-293

An Acoustic Source Modeling Technique to Predict the Near Sound Field of Axisymmetric Turbulent Jets

J.R. Maus, C.V. Sundaram, L.B. Bates, and M.G. Scott

Tennessee University Space Inst., Tullahoma, TN, Rept. No. AEDC-TR-79-36, 77 pp (May 1979)

AD-A069 627/8GA

Key Words: Jet engines, Engine noise, Mathematical models

The objective of the investigation is to develop a technique for determining the free, unreflected sound field produced by a jet engine based on sound measurements obtained in an engine test cell. A procedure has been developed for modeling the sound sources in an axisymmetric jet which allows prediction of the near sound field generated by the jet. The procedure involves modeling the sources for each one-third octave frequency band by a combination of uncorrelated elementary sources derived from the multipole expansion. The strengths of the various source components at a particular frequency are determined by a constrained least squares fit to the far field directivity pattern.

80-294

Noise Suppression in Jet Inlets

B.T. Zinn, W.I. Meyer, and W.A. Bell

School of Aerospace Engrg., Georgia Inst. of Tech., Atlanta, GA, Rept. No. AFOSR-TR-79-0614, 62 pp (Feb 1979)

AD-A069 787/0GA

Key Words: Jet engines, Jet noise, Noise reduction

This report summarizes the work performed during the second year of an AFOSR sponsored research program that was primarily concerned with the development of an analytical technique for determining the radiated sound field from axisymmetric jet engine inlet configurations. The analytical technique employed is based upon an integral representation of the external (radiation) solutions of the Helmholtz equation which describe the sound fields external to a given body under either no flow or constant velocity flow situations.

MISSILES AND SPACECRAFT

80-295

Effect of Vibration on Retention Characteristics of Screen Acquisition Systems

J.R. Tegart and J.C. Aydelott

Martin Marietta Corp., Denver, CO, J. Spacecraft Rockets, 16 (5), pp 319-325 (Sept/Oct 1979) 10 figs, 7 refs

Key Words: Spacecraft, Mathematical models

Analytical models to predict the effects of vibration on retention characteristics of screen acquisition systems are developed. A test program to verify the analytical models and allow a comparative evaluation of the parameters influencing the response to vibration is performed. Screen specimens were tested under conditions simulating the operation of an acquisition system, with the effects of such parameters as screen orientation and configuration, screen support method, screen mesh, liquid flow, and liquid properties considered.

80-296

Fluctuating Pressures on Mildly Indented Nosetips

J.P. Reding

Lockheed Missiles & Space Co., Inc., Sunnyvale, CA, J. Spacecraft Rockets, 16 (5), pp 302-310 (Sept/Oct 1979) 20 figs, 20 refs

Key Words: Spacecraft, Reentry vehicles, Shock wave propagation

Fluctuating pressure measurements at M = 5.0 are presented for turned (axisymmetric) nose shapes that represent approximations of cross sections (at various meridians) of the recovered graphite nosetip of the Nosetip Recovery Vehicle (NRV). Selected fluctuating pressure measurements are also presented for a replica of the NRV nosetip and a replica of a wind-tunnel-ablated camphor nosetip that roughly resembles the NRV nosetip.

MECHANICAL COMPONENTS

ABSORBERS AND ISOLATORS

(Also see Nos. 272, 280, 411)

80-297

Development Work on Steam Vent Pipe Silencing

J.K. Clayton and S.H. Cramer

Hopkinsons Ltd., Britannica Works, Huddersfield, Instn. Mech. Engr. Proc., 193, pp 245-251 (June 1979) 6 figs, 3 refs

Key Words: Silencers, Pipes (tubes), Boilers

The paper describes the practical steps taken in the development of a light-weight steam discharge silencer, mounted

at the outlet of the vent pipe. With various degrees of valve throttling of superheater start-up valves as well as safety valves, the sound pressure level (SPL) effects at the vent pipe outlet were analyzed before and after silencing. Various configurations of the silencer were tested on steam discharge. Steam flow rates were measured along with SPL.

80-298

Viscous Damper Qualification on Diesel Locomotive Engines - A Case History

H. Hershkowitz
Scientific-Atlanta, Inc., New Jersey Div., Randolph Township, NJ 07801, Machinery Vibration Monitoring and Analysis Seminar, Proc., Feb 13-15, 1978, Houston, TX, 17 pp
Sponsored by the Vibration Inst., Clarendon Hills, IL

Key Words: Vibration dampers, Diesel engines

This paper presents some results of a study in measuring the performance characteristics of viscous vibration dampers that are used on diesel locomotive engines. The material contained within this report was obtained with the cooperation of the Atchison, Topeka and Santa Fe Railway Company (ATSF) and relates to the viscous dampers that are used on large diesel engines of the type manufactured by the Electromotive Division of General Motors (EMD).

80-299

Damping of Cantilever Strips with Inserts

R. Rahmathullah and A.K. Mallik
Dept. of Mech. Engrg., Indian Inst. of Tech., Kanpur 208016, India, J. Sound Vib., 66 (1), pp 109-117 (Sept 8, 1979) 6 figs, 2 tables, 8 refs

Key Words: Material damping

The possibility of improving the damping capacity of cantilever strips by using high-damping inserts is studied experimentally. Results are presented for an aluminium strip with solid and annular inserts of three different materials; namely, cast iron, bakelite and perspex. First, the material damping characteristics of all the four materials are determined. These are calculated from the specimen damping obtained from the free vibration records of cantilever strips.

80-300

Evaluation of Pylon Focusing for Reduced Helicopter Vibration

R. Gabel and D. Reed
Boeing Vertol Co., Philadelphia, PA, Rept. No. D210-11390-1, USARTL-TR-79-6, 95 pp (Apr 1979)
AD-A069 712/8GA

Key Words: Isolators, Helicopter rotors, Helicopters, Rotor-induced vibration

A wind tunnel model test program is conducted to investigate the effectiveness of a focused isolation system in reducing the transmission of rotor-induced vibratory loads for a four-bladed hingeless rotor. The model consists of a four-bladed hingeless rotor and a simulated transmission mounted on a focal isolation system having pitch and roll degrees of freedom.

TIRES AND WHEELS

(Also see No. 377)

80-301

Tyre Factors and Vehicle Handling

H.B. Pacejka
Delft Univ. of Technology, The Netherlands, Intl. J. Vehicle Des., 1 (1), pp 1-23 (Oct 1979) 26 figs, 1 table, 11 refs

Key Words: Tire characteristics, Mathematical models, Cornering effects

The paper consists of two parts. First an outline is given of the functions of a tire as a vehicle component with a discussion of the development of mathematical models describing steady-state cornering behavior. Also, the concept of effective tire characteristics is discussed, which represents the combined effects of tire and elastic suspension and steering properties. The second part considers the motion of the vehicle over a horizontal flat surface with the longitudinal speed constant. After a discussion of steady-state cornering behavior and the introduction of a handling diagram showing regions of under-steer and over-steer, and regions of stable and unstable motion, the dynamic solution of the plane motion is studied.

BLADES

80-302

Three-Dimensional Velocity Distribution Between Stator Blades and Unsteady Force on a Blade Due to Passing Wakes

T. Adachi and Y. Murakami

Inst. of Structural Engrg., Univ. of Tsukuba, Japan, Bull. JSME, 22 (170), pp 1074-1082 (Aug 1979) 19 figs, 8 refs

Key Words: Blades, Aerodynamic loads

The steady and unsteady three-dimensional velocity distributions between the stator blades due to passing wakes shed by upstream moving cylinders are measured. The method utilizes a hot-wire located in three-coordinate directions respectively. The motion of the wake passing through the stator blade row and the effect of it on flow in a passage are considered and compared with the measured results of the unsteady force on the blade.

80-303

Modal Analysis of Compressor Blades by Means of Impulse Excitation

U. Bolleter, J. Eberl, and E. Buehlmann

Sulzer Brothers Ltd., Winterthur, Switzerland, In: AGARD, Stresses, Vibrations, Struc. Integration and Engr. Integrity (including Aeroelasticity & Flutter), 11 pp (Apr 1979)

N79-27165

Key Words: Blades, Compressor blades, Turbomachinery blades, Modal analysis

An experimental method of modal analysis is described which is based on impulse excitation. The modal behavior, particularly with respect to bending and torsional coupling, is demonstrated using a subsonic compressor blade as an example. Measured damping coefficients and inter-modal phase differences are discussed. Applications of the quantitative results of stress responses to point excitation are illustrated.

80-304

Determining the Dynamic Response due to an Imbalance at the Attachments of a Motor on a Pod (Determination des Efforts Dynamiques dus a un Balourd aux Attaches D'un Moteur Monte en Pode)

B. Schneider

Avions Marcel Dassault-Breguet Aviation, Saint-Cloud, France, In: AGARD, Stresses, Vibrations, Struc. Integration and Engr. Integrity (including Aeroelasticity & Flutter), 16 pp (Apr 1979)

N79-27171

(In French)

Key Words: Blades, Rotor blades, Blade loss dynamics

The loss of a rotor blade produces an imbalance which is transmitted to the attachments of an engine on a pod. The reactions of these attachments are calculated as a function of the angular velocity of the rotor by means of the matrix of flexibility of the pod, of inertial characteristics of the rigid engine and of the generalized mass, as well as of the frequency of the damping of the distortions of the flexible modes of the motor.

80-305

Unsteady Rotor Blade Loading in an Axial Compressor with Steady-State Inlet Distortions

M. Lecht and H.B. Weyer

Inst. f. Antriebstechnik, Deutsche Forschungs- und Versuchsanstalt f. Luft- und Raumfahrt, Cologne, West Germany, In: AGARD, Stress, Vibrations, Struc. Integration and Engr. Integrity (including Aeroelasticity and Flutter), 13 pp (Apr 1979)

N79-27176

Key Words: Blades, Rotor blades

A steady state measuring technique with conventional probes and pressure tapes combined with an adequate data analysis is used to investigate the unsteady rotor flow with particular respect to the variation of the blade loading during rotor revolution. Some relevant results of this investigation are submitted and discussed.

BEARINGS

(Also see No. 394)

80-306

An Experimental Method for the Determination of Journal-Bearing Stability Parameters. Part 1: Theory

H. Marsh and J.E.L. Simmons

Univ. of Durham, J. Mech. Engr. Sci., 21 (3), pp 179-185 (June 1979) 6 figs, 8 refs

Key Words: Bearings, Journal bearings, Stability, Rotor-bearing systems

This paper describes the basic theory of bearing stability and shows how this can be used to help in the design of a novel apparatus for determining the stability parameters of any journal-bearing system.

80-307

An Experimental Method for the Determination of Journal-Bearing Stability Parameters. Part 2: Experiment

J.E.L. Simmons

Univ of Durham, J. Mech. Engr. Sci., 21 (3), pp 187-196 (June 1979) 13 figs, 7 refs

Key Words: Bearings, Journal bearings, Stability, Rotor-bearing systems

The design of a flexibly mounted journal-bearing apparatus is described, and it is shown how the experimental results may be used to generate stability charts for design. For reasons of simplicity in demonstrating the basic principles, this work has been carried out using a plain circular air bearing. The theory is intended to extend the experimental method to liquid-lubricated bearings and non-circular profiles. In addition to the stability data which have been obtained, the apparatus has enabled a detailed study of the phenomenon of whirl cessation.

80-308

Vibration of Bearings

K.M. Ragulskis, A.Yu. Jurkauskas, V.V. Atstupenas, A.Yu. Vitkute, and A.P. Kulvec

NASA, Washington, D.C., Rept. No. NASA-TT-F-679; TT-75-52090, 395 pp (1979)

N79-27501

Key Words: Bearings, Vibration response, Vibration damping

The analytical determination of vibrations and friction torque due to rotation, taking into consideration the hydrodynamic action of a lubricating oil film, and the determination of the elastic and damping characteristics of bearings and bearing assemblies are presented.

80-309

Investigation of the Stability of Tilting Pad Bearings Taking the Mass of the Pad into Consideration (Untersuchung zum Stabilitätsverhalten von Kippsegmentlagern unter Berucksichtigung der Segmentmasse)

W. Streetz

Mannesmann-Demag Verdichter- und Drucklufttechnik AG, Duisburg, Germany, Konstruktion, 31 (8), pp 321-324 (Aug 1979) 6 figs, 8 refs

(In German)

Key Words: Bearings, Tilting pad bearings, Stability, Rotor-bearing systems

The effect of the mass of a pad on the stability of a rotor-bearing system is investigated using a single mass rotor as an example. The characteristic polynomial is obtained from the equations of motion and then solved numerically.

80-310

Bearing Noise in Electric Motors

L. Johansson

SKF Gothenburg, Ball Bearing J., 200, pp 28-31 (Aug 1979) 6 figs

Key Words: Bearings, Motors, Household appliances, Noise source identification

SKF has made a thorough study of the subject of bearing noise in electric motors. It was found that by accurate analysis of frequency spectra and amplitude modulations within the different frequency bands it was possible to identify the motor or bearing components at fault.

GEARS

80-311

Dynamic Behavior of Planetary Gear (7th Report, Influence of the Thickness of the Ring Gear)

T. Hidaka, Y. Terauchi, and K. Nagamura

Yamaguchi Univ., Tokiwa-Dai, Ube, Japan, Bull. JSME, 22 (170), pp 1142-1149 (Aug 1979) 18 figs, 2 tables, 7 refs

Key Words: Gears

The authors studied experimentally the influences of the thickness of a ring gear on the fillet stress of the ring gear and the load distribution among each planet gear. The planetary gear used in this study is a single-stage Stoeckicht planetary gear (Type 2K-H) constructed with spur gears.

STRUCTURAL COMPONENTS

STRINGS AND ROPES

80-312

The Fate of Secondary Waves in Self-Excited Vibrations of String Instruments (Das Schicksal der Sekundarwellen bei der Selbsterregung von Streichinstrumenten)

L. Cremer

Mitteilung aus dem Institut f. technische Akustik der Technischen Universität Berlin, Germany, Acustica, 42 (3), pp 133-148 (May 1979) 12 figs, 15 refs (In German)

Key Words: Strings, Self-excited vibrations

The fate of secondary waves in self-excited vibrations of string instruments is studied in this paper.

CABLES

(See Nos. 219, 343)

BARS AND RODS

80-313

Finite-Element Solution of Added Mass and Damping of Oscillation Rods in Viscous Fluids

C.-I. Yang and T.J. Moran

Components Tech. Div., Argonne National Lab., Argonne, IL 60439, J. Appl. Mech., Trans. ASME, 46 (3), pp 519-523 (Sept 1979) 5 figs, 1 table, 11 refs

Key Words: Rods, Cylindrical bodies, Viscoelastic damping, Finite element technique

This paper presents a finite-element analysis for the cylindrical rods oscillating periodically in an incompressible viscous fluid. A system of discretized equation is obtained from the appropriate Navier-Stokes and continuity equations through Galerkin's process. A mixed interpolation method is used. The added mass and viscous damping coefficients which characterize the fluid reaction force due to the rods oscillation can be obtained through a line integration of stress and pressure around the circumference of the rods.

BEAMS

80-314

An Accurate Approximate Formula for the Natural Frequencies of Sandwich Beams

A. Rutenberg

Faculty of Civil Engrg., Technion-Israel Inst. of Tech., Haifa, Israel, Computers Struc., 10 (6), pp 875-878 (Dec 1979) 1 fig, 5 tables, 9 refs

Key Words: Beams, Cantilever beams, Sandwich structures, Natural frequencies

A formula proposed for evaluating the fundamental frequencies of cantilever sandwich beams is generalized for higher modes and other boundary conditions, and is shown to be in very good agreement with experimental and theoretical values.

80-315

Vibrations of a Beam with Nonlinear Elastic Constraints

H. Saito and K. Mori

Dept. of Mech. Engrg., Tohoku Univ., Sendai, Japan, J. Sound Vib., 66 (1), pp 1-8 (Sept 8, 1979) 8 figs, 6 refs

Key Words: Beams, Flexural vibration, Harmonic response

The transverse vibrations of a beam, with both ends supported on non-linear elastic constraints, carrying a concentrated mass and subjected to a transverse periodic force are analyzed. The non-linear constraints are represented by rotational and translational springs having both linear and cubic non-linear behavior. The harmonic responses of a beam

involving the third order superharmonic and the one-third order subharmonic are considered. The beam responses to the effects of non-linear elastic constraints are discussed by taking two cases.

80-316

Optimum Distribution of Additive Damping for Vibrating Beams

R. Lunden

Div. of Solid Mechanics, Chalmers Univ. of Tech., S-41296 Gothenburg, Sweden, J. Sound Vib., 66 (1), pp 25-37 (Sept 8, 1979) 9 figs, 19 refs

Key Words: Beams, Vibrating structures, Damping, Harmonic excitation

Cost and weight effectiveness of concentrated and distributed additive damping is studied for linear systems (discrete and continuous) under prescribed harmonic loads and/or displacements. Stiffness and mass changes due to additive damping are included. The optimization technique as well as an exact displacement method for analysis of harmonically vibrating beams and frames are presented.

CYLINDERS

(Also see No. 313)

80-317

Prediction of Aerodynamic Forces on a Circular Cylinder and a Thin Airfoil in a Transonic Airstream by the Finite Element Method

J.E. Marsh

Ph.D. Thesis, Air Force Inst. of Tech., 184 pp (1979) UM 7920914

Key Words: Cylinders, Airfoils, Aerodynamic loads, Finite element technique

The finite element method is used to solve the nonlinear, small-disturbance, transonic, velocity-potential equation for problems of steady flow over a circular cylinder and over a thin-airfoil in a uniform steady airstream.

COLUMNS

80-318

Development of Loading Systems and Initial Tests - Short Columns Under Bidirectional Loading

J.O. Jirsa, K. Maruyama, and H. Ramirez

Structures Research Lab., Texas Univ. at Austin, TX, Rept. No. CESRL-78-2, NSF/RA-780605, 77 pp (Sept 1978)

PB-297 542/3GA

Key Words: Columns (supports), Dynamic tests, Testing techniques

The object of this report is to describe the special loading facilities developed for the application of bidirectional lateral loads and varying axial loads (tension and/or compression) on short columns failing in shear. The design of the specimen is discussed and the instrumentation used to monitor the behavior is described. Finally, the results of four test specimens are presented to give an indication of the capabilities of the loading and data acquisition systems developed.

80-319

Mathematical Modelling of Hysteresis Loops for Reinforced Concrete Columns

S. Nakata, T. Sproul, and J. Penzien

Earthquake Engrg. Research Ctr., California Univ., Richmond, CA, Rept. No. UCB/EERC-78/11, NSF/RA-780632, 92 pp (June 1978)

PB-298 274/2GA

Key Words: Columns (supports), Reinforced concrete, Earthquake response, Mathematical models

The objective of this research is to estimate lateral force-deflection curves for reinforced concrete columns subjected to cyclic transverse loads and constant axial loads. These curves are determined in relation to particular column parameters such as shear-span ratio, longitudinal and horizontal reinforcement, and axial force. The data for this project were obtained from a series of tests reported by Atalay and Penzien and a series of tests made in Japan. 104 specimens are selected from the latter test series, with shear span ratios ranging from 1.0 to 3.0. Summary equations are developed by statistical methods.

FRAMES AND ARCHES

80-320

Nonlinear Static and Dynamic Analysis of Framed Structures

S.N. Remseth
SINTEF - The Foundation of Scientific and Industrial Research at the Norwegian Inst. of Tech., 7034 Trondheim-NTH, Norway, Computers Struc., 10 (6), pp 879-897 (Dec 1979) 21 figs, 4 tables, 23 refs

Key Words: Framed structures, Nonlinear theories, Dynamic structural analysis

The present study is concerned with methods of nonlinear static and dynamic analysis of structures, particularly for application to geometrically nonlinear space frames. The displacement formulation of the finite element method is adopted. Large displacements are accounted for by using a material (Lagrangian) description of motion from a fixed reference frame, assuming small strains and moderately large rotations. Curved beam elements are considered by introduction of initial deflections in the element stiffness relations. Higher order axial interpolation polynomials are included in order to obtain an appropriate coupling between axial forces and bending for the frame members. The efficiency of nonlinear numerical solution methods are discussed in connection with the nonlinear dynamic response analyses presented.

MEMBRANES, FILMS, AND WEBS

(Also see No. 323)

80-321

Dynamic Response of a Membrane with Both Curved and Straight Line Boundaries

K. Nagaya
Dept. of Mech. Engrg., Yamagata Univ., Yonezawa, Japan, J. Appl. Mech., Trans. ASME, 46 (3), pp 667-671 (Sept 1979) 6 figs, 16 refs

Key Words: Membranes, Boundary value problems, Frequency equations

In this paper a method for solving vibration and dynamic response problems of a membrane having an arbitrary shaped boundary consisting of curved and straight lines is presented. The frequency equation for the arbitrary-shaped membrane is given, and the solution for the membrane subjected to general transient load is obtained in a generalized form. As a numerical example, the response of a parabolic membrane subjected to a uniformly distributed exponentially decaying load is investigated.

PLATES

(Also see Nos. 343, 412)

80-322

An Improved Nonlinear Dynamic Analysis of Flat Laminated Plates

A.R. Zak and D.W. Pillasch
Dept. of Aeronautical and Astronautical Engrg., Illinois Univ. at Urbana-Champaign, IL, Rept. No. ARBRL-CR-00394, SBIE-AD-E430 240, 27 pp (Mar 1979)
AD-A069 670/8GA

Key Words: Plates, Laminates, Finite element technique, Mathematical models

An improved finite element structural model is developed for the dynamic analysis of flat laminated plates. The new model allows for orthotropic elastic-visco-plastic material response and it uses finite difference equations for the time integration technique.

80-323

The Unsteady Aerodynamics of a Cascade in Translation

S. Fleeter, R.E. Riffel, T.H. Lindsey, and M.D. Rothrock
Cascade and Flow Systems Res., Detroit Diesel Allison, Indianapolis, IN, In: AGARD, Stresses, Vibrations, Struc. Integration and Engr. Integrity (including Aeroelasticity and Flutter), 13 pp (Apr 1979)
N79-27180

Key Words: Airfoils, Plates, Aerodynamic characteristics, Harmonic analysis

The fundamental time variant translation mode aerodynamics are determined for a classical airfoil cascade in a supersonic inlet flow field over a range of interblade phase angles at a realistic reduced frequency value. These experimental data

are then correlated with predictions obtained from an appropriate state-of-the-art harmonically oscillating flat plate cascade aerodynamic analysis.

80-324
A Note on Transverse Vibrations of Annular Plates Elastically Restrained Against Rotation Along the Edges

D.R. Avalos and P.A.A. Laura
Universidad Nacional de Mar del Plata, J. Sound Vib., 66 (1), pp 63-67 (Sept 8, 1979) 4 figs, 1 table, 4 refs

Key Words: Plates, Flexural vibration, Vibrating structures

The title problem is solved by using simple polynomial expressions which identically satisfy the boundary conditions. A variational method is applied in order to generate a frequency determinant.

80-325
Extended Field Method Free Vibration Solutions

S. Chander and B.K. Donaldson
Control Data Corp., Rockville, MD, J. Sound Vib., 66 (1), pp 53-62 (Sept 8, 1979) 2 figs, 4 tables, 8 refs

Key Words: Plates, Rectangular plates, Extended field method, Free vibration

An apparent paradox involving the relation between the plate bending natural frequencies of two elastic plates when one plate encloses the other is examined.

80-326
Vibrations of Heated Plates with Two Opposite Edges Simply Supported

N. Ganesan
Dept. of Appl. Mech., Indian Inst. of Tech., Madras-600 036, India, J. Sound Vib., 66 (1), pp 99-107 (Sept 8, 1979) 1 fig, 5 tables, 8 refs

Key Words: Plates, Rectangular plates, Temperature effects, Variable material properties, Vibration response

In the present paper a vibration analysis of rectangular plates with two opposite sides simply supported which are heated so as to have a temperature varying in the direction parallel to these sides is presented. A steady state temperature which satisfies the Laplace equation is considered.

80-327
Thickness Oscillations in Deformed Elastic Plate

M. Hirao and H. Fukuoka
Dept. of Mech. Engrg., Faculty of Engrg. Science, Osaka Univ., Toyonaka, Osaka 560, Japan, J. Appl. Mech., Trans. ASME, 46 (3), pp 663-666 (Sept 1979) 9 refs

Key Words: Plates, Oscillation

The theory of elastic waves superposed on finite deformation is applied to the study of thickness oscillations in a deformed elastic plate. Perturbation scheme, based on multiple scales, is employed to obtain a set of governing equations for the amplitudes of transverse thickness oscillations which are perpendicularly polarized with each other.

80-328
Eigenfrequencies of Continuous Plates with Arbitrary Number of Equal Spans

I. Elishakoff and A. Sternberg
Dept. of Aeronautical Engrg., Technion-Israel Inst. of Tech., Haifa, Israel, J. Appl. Mech., Trans. ASME, 46 (3), pp 656-662 (Sept 1979) 1 fig, 2 tables, 36 refs

Key Words: Plates, Rectangular plates, Natural frequencies

An approximate analytical technique is developed for determination of the eigenfrequencies of rectangular isotropic plates continuous over rigid supports at regular intervals with arbitrary number of spans. All possible combinations of simple support and clamping at the edges are considered. The solution is given by the modified Bolotin method, which involves solution of two problems of the Voigt-Lévy type in conjunction with a postulated eigenfrequency/wave-number relationship.

80-329
Dynamic Analysis of Flexible Plates Bearing on the Elastic Half-Space
W.L. Whittaker
Ph.D. Thesis, Carnegie-Mellon Univ., 203 pp (1979)
UM 7919158

Key Words: Plates, Elastic foundations, Harmonic excitation

This investigation analyzes the dynamic interaction of an elastic flexural plate and an elastic half-space when the system is subjected to harmonic excitation in the form of either external forces or seismic waves. Attention is directed to the displacement responses of rectangular plates and the associated contact pressures that develop on the frictionless contact area for a range of flexural stiffness. The harmonic analysis of the plate-subgrade system is conducted within the framework of a global stiffness solution.

80-330
Free Vibration of Rotating Non-Uniform Discs: Spline Interpolation Technique Calculations
T. Irie, G. Yamada, and R. Kanda
Dept. of Mech. Engrg., Hokkaido Univ., Sapporo 060, Japan, J. Sound Vib., 66 (1), pp 13-23 (Sept 8, 1979) 8 figs, 14 refs

Key Words: Disks (shapes), Variable cross section, Rotating structures, Natural frequencies, Mode shapes, Flexural vibration

Stress distributions and flexural vibration of rotating annular discs with radially varying thickness are calculated by means of a sp[illegible] interpolation technique. For this purpose, the disc is divided into many ring-shaped elements and the radial displacement is expressed as a cubic spline function. Centrifugal stress distributions are calculated from the radial displacement. The transverse deflection of the disc is expressed as a quintic spline function. The method is applied to free-clamped rotating discs with linearly, parabolically and exponentially varying thickness, the natural frequencies and the mode shapes are calculated numerically, and the effects of rotating velocity and variable thickness are discussed.

SHELLS

(Also see No. 343)

80-331
Coincidence of Higher-Order Modes - A Mechanism of the Excitation of Cylindrical Shell Vibrations Via Internal Sound
J.L. Walter
Ph.D. Thesis, The Pennsylvania State Univ., 180 pp (1979)
UM 7922360

Key Words: Shells, Cylindrical shells, Acoustic excitation

This dissertation studies a mechanism of the excitation of cylindrical shell vibrations via internal sound.

80-332
Modal Response of a Circular Cylindrical Shell with Damping Layers
K.M. Iyer
Ph.D. Thesis, The Ohio State Univ., 117 pp (1979)
UM 7922503

Key Words: Shells, Cylindrical shells, Layered damping, Modal analysis

A set of equations to represent the forced vibrations of a circular cylindrical shell with damping layers is developed. The shell could have inside and/or outside layers. Classical thin shell theory is used in the development of the shell equations. A method is shown for combining the strain-displacement expressions, the stress resultant expressions and the general equations of motion by making use of matrix algebra. The equations have been expressed in a non-dimensional form. Computer programs are written (in Fortran IV) to obtain the modal response of the shell at various frequencies. Numerical results for various combinations of shell parameters (given in graphical and tabular form) are discussed to show the effect of damping layers.

80-333
Dynamic Analysis of Cylindrical Shells with Cutouts and Cracks
H.T. Tezduyar
Ph.D. Thesis, Univ. of Notre Dame, 205 pp (1979)
UM 7919961

Key Words: Cylindrical shells, Hole-containing media, Computer programs

Steady-state vibrations of a finite cylindrical shell with cutouts and cracks subjected to harmonic surface load are studied. The dynamical form of Morley's governing differential equations are derived and utilized to remove the rather severe restrictions imposed by Donnell's equations.

80-334

Transient Response of Two Fluid-Coupled Cylindrical Elastic Shells to an Incident Pressure Pulse

H. Huang
Ocean Tech. Div., Naval Research Lab., Washington, D.C. 20375, J. Appl. Mech., Trans. ASME, 46 (3), pp 513-518 (Sept 1979) 7 figs, 10 refs

Key Words: Cylindrical shells, Shells, Transient response

The transient response of a system of two initially concentric circular cylindrical elastic shells coupled by an ideal fluid and impinged upon by an incident plane pressure pulse is studied. The classical techniques of separation of variable and Laplace transforms are employed for simultaneously solving the wave equations governing the fluid motions and the shell equations of motion. The transformed solutions are arranged in such a manner that their inverse transforms can be accurately calculated by solving a set of Volterra integral equations in the time domain. A sample calculation of shell responses is performed and results are compared to the case in which the outer shell is absent.

PIPES AND TUBES

(See Nos. 250, 252, 297)

DUCTS

80-335

The Influence of a Submerged Duct on Sound Propagation in a Surface Duct

M. Hall
R.A.N. Research Lab., P.O. Box 706, Darlinghurst, New South Wales 2010, Australia, J. Acoust. Soc. Amer., 66 (4), pp 1102-1107 (Oct 1979) 7 figs, 1 table, 6 refs

Key Words: Ducts, Submerged structures, Sound waves, Wave propagation

Acoustic intensities at receivers in a surface duct and in a deep submerged duct are calculated using a normal-mode theory. The sound source is in the surface duct, which is 60 m thick, and the calculations are repeated for thicknesses of the submerged duct ranging from 0 to 150 m, at frequencies from 160 to 400 Hz.

80-336

An Experimental Study of Sound Radiation from Hyperboloidal Inlet Ducts

L.R. Clark and Y.C. Cho
NASA Langley Research Ctr., Hampton, VA, Rept. No. NASA-TM-80109, 19 pp (June 1979)
N79-27931

Key Words: Ducts, Sound waves

Sound radiation from hyperboloidal inlet ducts which include a circular cylinder with plane baffle as a limiting case is investigated. Results include the polar angle variation of the pressure level and the phase of the radiated field for various frequencies and various modes incident which were produced using an electronically operated mode synthesizer. Good agreement with a rigorous theoretical prediction was found.

80-337

Analysis, Design, and Test of Acoustic Treatment in a Laboratory Inlet Duct

R.E. Kraft, R.E. Motsinger, W.H. Gauden, and J.F. Link
Aircraft Engine Group, General Electric Co., Evendale, OH, Rept. No. NASA-CR-3161, 81 pp (July 1979)
N79-27934

Key Words: Ducts, Noise reduction, Modal analysis

A suppression prediction program based on the method of modal analysis for spinning mode propagation in a circular duct is used in the analytical design of optimized, multi-element, Kevlar bulk-absorber treatment configurations for an inlet duct. The NASA-Langley ANRL anechoic chamber using the spinning mode synthesizer as a sound source is used to obtain in-duct spinning mode measurements, radial mode measurements, and far-field traverses, as well as aerodynamic measurements. The measured suppression values are compared to predicted values, using the in-duct, forward-traveling, radial-mode content as the source for the prediction. The performance of the treatment panels is evaluated from the predicted and measured data.

80-338

On the Attenuation of Sound by Three-Dimensionally Segmented Acoustic Liners in a Rectangular Duct

W. Koch

NASA Langley Research Ctr., Hampton, VA, Rept. No. NASA-TM-80118, 29 pp (June 1979)
N79-27932

Key Words: Ducts, Acoustic linings, Noise reduction

Advanced liner concepts are proposed which induce a modal energy transfer in both cross-sectional directions to further reduce the noise radiated from turbofan engines. A very simple three-dimensional problem is investigated analytically.

80-339

Studies of the Acoustic Transmission Characteristics of Coaxial Nozzles with Inverted Velocity Profiles: Comprehensive Data Report

P.D. Dean, M. Salikuddin, K.K. Ahuja, H.E. Plumblee, and P. Mungur

Lockheed-Georgia Co., Marietta, GA, Rept. No. NASA-CR-159628, 182 pp (May 1979)
N79-27933

Key Words: Sound transmission, Nozzles

The efficiency of internal noise radiation through a co-annular exhaust nozzle with an inverted velocity profile is studied. A preliminary investigation is undertaken to define the test parameters which influence the internal noise radiation; to develop a test methodology which could be used to examine the effects of the test parameters; and to validate this methodology.

BUILDING COMPONENTS

(Also see No. 266)

80-340

Transient Response of Continuous Viscoelastic Structural Members

J. Strenkowski and W. Pilkey

Dept. of Mech. and Aerospace Engrg., North Carolina State Univ., Raleigh, NC 27650, J. Appl. Mech., Trans. ASME, 46 (3), pp 685-690 (Sept 1979) 7 refs

Key Words: Structural members, Viscoelasticity, Transient response, Modal analysis

In this paper a comprehensive theory is formulated for the dynamic response of structural members with a constitutive relation in the form of a hereditary integral. A modal approach is taken to uncouple the response due to an arbitrary excitation force and general nonhomogeneous surface tractions.

80-341

An Analytical Theory of Resonant Scattering of SH Waves by Thin Overground Structures

C.C. Mei and M.A. Foda

Parsons Lab., Dept of Civil Engrg., Massachusetts Inst. of Tech., Cambridge, MA, Intl. J. Earthquake Engr. Struc. Dynam., 7 (4), pp 335-353 (July/Aug 1979) 5 figs, 17 refs

Key Words: Secondary waves, Seismic waves, Wave diffraction, Structural members

Scattering of SH waves in a half-space with simple overground structures is studied analytically. For two-dimensional structures, such as shells, shear walls and a slab-bridge over a river, the method of matched asymptotics is used for sinusoidal waves long compared to the thickness of the structures. Resonance features are deduced analytically and calculated numerically for various incidences and other parameters.

80-342

Seismic Design of Retaining Walls and Cellular Cofferdams

S. Chakrabarti, A.D. Husak, P.P. Christiano, and D.E. Troxell

D'Appolonia Consulting Engineers, Inc., Pittsburgh, PA, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. I, pp 325-341, 4 figs, 10 refs

Key Words: Retaining walls, Walls, Seismic design

This paper illustrates extensions of the static design techniques, and compares the factors of safety obtained from static and pseudo-static (seismic) analyses. Certain design criteria, which have been modified to account for dynamic action, are explained. Local soil, rock and hydrostatic conditions, as well as liquefaction potential and hydrodynamic forces, are considered.

80-343
Static and Dynamic Finite Deformations of Viscoelastic Solids and Structures
B.J. Sullivan
Ph.D. Thesis, Univ. of Pennsylvania, 235 pp (1979)
UM 7919525

Key Words: Plates, Cables, Shells, Finite element technique

In this work static and dynamic finite deformation problems involving viscoelastic cables, circular plates, and shells of revolution are investigated. By means of this technique, the Rate Equation Method, a set of linear differential equations in the displacement rates and stress resultant rates are obtained from the governing nonlinear differential equations associated with finite deflections. These linear differential equations are solved numerically for the rate variables.

80-344
Fatigue Strength of Fillet Welded Cruciform Joints
K.H. Frank and J.W. Fisher
The Univ. of Texas at Austin, TX, ASCE J. Struc. Div., 105 (ST9), pp 1727-1740 (Sept 1979) 11 figs, 1 table, 12 refs

Key Words: Joints (junctions), Welded joints, Fatigue life

A method for determining the fatigue strength of fillet welded cruciform joints is presented. The inadequacy of the present fatigue specification is examined through comparison with experimental data. The significance of the lack of penetration occurring at the weld root upon experimental fatigue is presented. A fracture mechanics model of the fatigue behavior is developed and correlated with experimental results. Design equations based on the model and a design example are presented.

ELECTRIC COMPONENTS

ELECTRONIC COMPONENTS

(See No. 388)

DYNAMIC ENVIRONMENT

ACOUSTIC EXCITATION

(Also see Nos. 273, 274, 276, 277, 290, 291, 293, 294, 331, 335, 336, 337, 338, 339, 369, 381, 382, 384)

80-345
Reciprocal Acoustic Transmission in a Midocean Environment: Fluctuations
P.F. Worcester
Scripps Instn. of Oceanography, Univ. of California, San Diego, La Jolla, CA, J. Acoust. Soc. Amer., 66 (4), pp 1173-1181 (Oct 1979) 13 figs, 4 tables, 16 refs

Key Words: Underwater sound, Sound transmission

The fluctuations in acoustic receptions from simultaneous transmission of broadband pulses in opposite directions between two points in midocean are examined.

80-346
Effects of Tidally Varying Sound Speed on Acoustic Propagation Over a Sloping Ocean Bottom
K.G. Hamilton, W.L. Siegmann, and M.J. Jacobson
Rensselaer Polytechnic Inst., Troy, NY 12181, J. Acoust. Soc. Amer., 66 (4), pp 1108-1119 (Oct 1979) 7 figs, 17 refs

Key Words: Underwater sound, Sound waves, Wave propagation

The influence of sound-speed fluctuations on propagation of a CW signal in an ocean with a uniformly sloping bottom and a horizontal surface is analyzed using ray theory. The mean sound-speed structure is modeled as bilinear, with bottomed source and receiver above and below the SOFAR axis, respectively. The total acoustic field is investigated for its dependence on these parameters and time.

80-347

Transient Acoustic Radiation from Elastic Plates

S. Mackertich Sengerdy

Ph.D. Thesis, The Pennsylvania State Univ., 111 pp (1979)

UM 7922312

Key Words: Elastic waves, Sound waves

An expression for the acoustic radiated pressure emanating from an infinite elastic plate excited by a unit impulse load for different observation angles and distances is obtained analytically. The solution is obtained by use of Fourier transform in time and Hankel transform on the radial coordinate. Using Cauchy contour integration theorem and regular and modified saddle-point methods, the inverse Fourier and Hankel transforms were evaluated. The unit impulse response and convolution theorem was then utilized to obtain an expression for radiated pressure of an infinite elastic plate excited by constant magnitude load, square pulse and CW-pulse loads.

80-348

The Scattering of Spherical Pulses by Slightly Rough Surfaces

I. Tolstoy

Naval Postgraduate School, Monterey, CA 93940, J. Acoust. Soc. Amer., 66 (4), pp 1135-1144 (Oct 1979) 5 figs, 13 refs

Key Words: Acoustic scattering, Wave diffraction, Surface roughness

Using a small roughness boundary condition due to Biot, which incorporates the effects of multiple scatter, one can obtain simple, closed-form solutions for the coherent scattering of transient spherical waves. Combining this boundary condition with the normal coordinate technique leads to explicit solutions for impulsive or other point sources above or on a rough, rigid plane, i.e., for both finite and grazing angles of incidence.

80-349

The Scattered Acoustic Boundary Wave Generated by Grazing Incidence at a Slightly Rough Rigid Surface

H. Medwin, J. Bailie, J. Bremhorst, B.J. Savage, and I. Tolstoy

Physics and Chemistry Dept., Naval Postgraduate School, Monterey, CA 93940, J. Acoust. Soc. Amer., 66 (4), pp 1131-1134 (Oct 1979) 8 figs, 6 refs

Key Words: Acoustic scattering, Wave diffraction, Surface roughness

A model experiment has been conducted using a point source and receiver embedded in a rough plane surface constructed of close-packed rigid hemispherical bosses and the prediction of the amplitude of the boundary wave has been fully confirmed.

80-350

The Measurement of Sound Levels in Hospitals

U. deCamp

Institut f. Technische Akustik, Technische Universität Berlin, Einsteinufer 27, D 1000 Berlin 10, Federal Rep. of Germany, Noise Control Engr., 13 (1), pp 24-27 (July/Aug 1979) 6 figs, 24 refs

Key Words: Sound measurement, Hospitals, Standards and codes

The measurement of sound levels in hospitals is investigated.

SHOCK EXCITATION

(Also see Nos. 227, 228, 229, 235, 239, 241, 242, 243, 248, 249, 251, 253, 254, 255, 256, 257, 258, 259, 260, 264, 269, 270, 296, 342, 383, 392, 402, 407)

80-351

Nonlinear Propagation of an Asymmetric Double Exponential Waveform

P.H. Rogers and A.M. Weiner

Naval Research Lab., Orlando, FL 32856, J. Acoust. Soc. Amer., 66 (4), pp 1188-1194 (Oct 1979) 9 figs, 5 refs

Key Words: Shock wave propagation

A weak-shock solution is obtained for the nonlinear propagation of a waveform that initially has the form of an asymmetric double exponential. Simple formulas for wave amplitude, shock amplitude, and arrival time are given as is an expression for the waveform. A general technique for obtaining weak-shock solutions for the amplitude of any integrable waveform that forms a single shock is also presented.

80-352

Experimental Investigation of First- and Second-Sound Shock Waves in Liquid Helium II

J.L. Wise

Ph.D. Thesis, California Inst. of Tech., 140 pp (1979)

UM 7922057

Key Words: Shock wave propagation, Experimental data

This paper discusses an experimental investigation of first- and second-sound shock waves in liquid helium II.

80-353

Stability of Shock Waves of Arbitrary Strength with Viscosity and Heat Conduction

M. Morduchow and J.V. Valentino

Polytechnic Inst. of New York, Brooklyn, NY 11201, J. Appl. Mech., Trans. ASME, 46 (3), pp 505-509 (Sept 1979) 2 figs, 2 tables, 9 refs

Key Words: Shock waves, Eigenvalue problems, Stability

The problem of the stability of shock waves with viscosity and heat conduction has been previously formulated as an eigenvalue problem involving a set of linear ordinary differential equations in a finite domain with what are shown to be regular singular points at the ends of the domain. Some actual solutions of the disturbance equations are shown.

80-354

Summary of Seismic Discrimination and Explosion Yield Determination Research

T.C. Bache, J.M. Savino, S.M. Day, J.T. Cherry, and H.J. Swanger

Systems Science and Software, La Jolla, CA, Rept. No. SSS-R-79-3847, 138 pp (Nov 1978)

AD-A069 802/7GA

Key Words: Seismic detection, Underground explosions, Nuclear explosions

This report summarizes the work accomplished in a twenty-four month research program directed toward resolution of technical issues arising in the seismic verification of an underground nuclear test ban treaty. Emphasis is on research conducted during the last year in five subject areas: data analysis, source studies, grout experiments, surface wave studies and body wave studies. Results are summarized for thirteen research projects. The report also includes an appendix in which abstracts are listed for seventeen technical reports submitted under this contract. Also included are the abstracts for twelve reports submitted under a preceding fifteen month contract.

80-355

Effect of Burial Depth on Seismic Signals. Volume I

N. Perl. F.J. Thomas, J. Trulio, and W.L. Woodie

Pacific-Sierra Research Corp., Santa Monica, CA, Rept. No. PSR-815-VOL-1, 58 pp (May 1979)

AD-A069 863/9GA

Key Words: Seismic detection, Underground explosions, Nuclear explosions

This report discusses a calculational program aimed at improving the U.S. capability to verify a Threshold Test Ban Treaty (TTBT) by seismic means. The analysis emphasizes shallow bursts, examining both body-wave and surface-wave effects. Two-dimensional inelastic source calculations, using Applied Theory's AFTON program, were made on a representative set of 150 KT explosions. Simple elastic theory is reviewed.

80-356

Seismic Velocities of San Francisco Bayshore Sediments

R.C. Wilson, R.E. Warrick, and M.J. Bennett

U.S. Geological Survey, Menlo Park, CA, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 1007-1023, 8 figs, 1 table, 11 refs

Key Words: Seismic waves, Wave propagation, Experimental data

Data gathered from seven borings in the southern San Francisco Bayshore area show that each of the three Quaternary geologic formations - Holocene Bay Mud, Young (late Quaternary) Alluvium, and Older (mid-Quaternary) Alluvium - has a characteristic set of soil types, geotechnical properties, and seismic wave velocities.

80-357

Influence of Faulting on Earthquake Attenuation

G.J. Bureau

International Engrg. Co., Inc., San Francisco, CA, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. I, pp 290-307, 11 figs, 1 table, 31 refs

Key Words: Earthquakes, Wave attenuation, Mathematical models

Mathematical formulations are proposed to correlate earthquake peak acceleration and distance for different types of faulting. Data from several historical events are used as examples.

80-358

Simple Shear Behavior of Fine Grained Soils Subjected to Earthquake and Other Repeated Loading

T.F. Zimmie and C.H.L. Floess

Dept. of Civil Engrg., Rensselaer Polytechnic Inst., Troy, NY, Rept. No. NSF/RA-790094, 140 pp (Mar 1979)

PB-298 123/1GA

Key Words: Soils, Earthquake response

This report contains the results of a laboratory investigation on the behavior of fine grained soils subjected to repeated loads. Emphasis is placed on high strain level repetitive loading such as that caused by earthquakes and storm waves. Consolidated constant volume (CCV) tests are performed using a Norwegian Geotechnical Institute (NGI) direct simple shear device. Included in this report is a literature review, a discussion of the stress conditions existing in direct simple shear samples, a description of equipment and testing procedures, and the presentation of test results.

80-359

Comparison of Dynamic Analyses for Saturated Sands

W.D.L. Finn, G.R. Martin, and M.K.W. Lee

Univ. of British Columbia, Vancouver, B.C., Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. I, pp 472-491, 13 figs, 15 refs

Key Words: Soils, Earthquake response

A number of different methods are now available for the analysis of the dynamic response of saturated cohesionless soils to earthquake loading. The methods differ in the simplifying assumptions that are made, in the representation of the stress-strain relations of soils, in the manner in which the development of pore-water pressure is taken into account and in the methods used to integrate the equations of motion. Three methods, used in engineering practice, are applied to the same idealized site profile to determine how their predictions compare and to assess their range of applicability and to clarify the characteristics of each method.

80-360

Response Spectra for Soft Soil Sites

E. Faccioli

Istituto di Scienza e Tecnica delle Costruzioni, Politecnico di Milano, Italy, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. I, pp 441-456, 6 figs, 17 refs

Key Words: Soils, Spectrum analyses

Spectral response characteristics of soft soil sites, illustrated by a set of strong-motion accelerograms from several countries of the Circum-Pacific Belt zone, are studied by regression analyses on magnitude and distance. Pseudovelocity (PSV) response ordinates at 15 values of natural period and 0.05 damping, as well as peak ground acceleration (PGA), velocity (PGV), and displacement (PGD) are considered.

80-361

Prediction of Free-Field Earthquake Ground Motions

C.B. Crouse

Fugro, Inc., Long Beach, CA, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. I, pp 359-379, 9 figs, 2 tables, 25 refs

Key Words: Ground motion, Earthquake response, Interaction: soil-structure

The existing strong motion data and the work of previous researchers are studied with regard to the problems in predicting the spectra of free-field earthquake ground motions. The main problems associated with the prediction of both Fourier and response spectra that are addressed in this paper are the effects due to several types of soil-structure inter-

action and local soil conditions and the possible biasing of spectral predictions from the use of a large amount of data from the 1971 San Fernando earthquake.

80-362

Dynamic Modulus and Damping Relationships for Sands

T.B. Edil and G. Luh

Dept. of Civil and Environmental Engrg. & Engrg. Mechanics, Univ. of Wisconsin, Madison, WI, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. I, pp 394-409, 7 figs, 3 tables, 15 refs

Key Words: Sand, Dynamic shear modulus, Damping

The dynamic response of a large number of uniform-sized, dry sands and a limited number of improved gradations is obtained from resonant column tests, and the data are analyzed to evaluate the effects of grain characteristics (size, gradation, shape, surface texture) and other test variables (e.g., ambient stress conditions, void ratio or relative density, strain amplitude, number of loading cycles) on the dynamic shear modulus and the damping capacity.

80-363

Dynamic Properties of Lime and LFA Treated Soils

Y.S. Chae and J.C. Chiang

Rutgers Univ., Piscataway, NJ, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. I, pp 308-324, 15 figs, 8 refs

Key Words: Soils, Dynamic shear modulus, Damping

This paper reports an experimental investigation of the dynamic properties of lime- and lime-fly ash treated soils. The purpose of this investigation is to provide some of the needed information on the dynamic properties of some soils treated with additives. The dynamic properties in terms of dynamic shear modulus of and damping in two soils, a uniform sand and a silty clay, treated with lime- and lime-fly ash are determined by the resonant column technique. Test variables studied are treatment level (additive content), confining pressure, shear-strain amplitude and moisture content.

80-364

Magnitude-Dependent Near Source-Ground Motion Spectra

J.A. Johnson and M.L. Traubenik

Dames & Moore, Los Angeles, CA, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. I, pp 530-539, 7 figs, 3 tables, 9 refs

Key Words: Seismic design, Ground motion, Shock response spectra, Spectrum analysis

Currently accepted procedures for estimating design response spectra are in general independent of magnitude. Based on these procedures, normalized, constant spectral shapes are developed which are then scaled to a prescribed magnitude-dependent peak acceleration. A study is performed for near source rock sites.

VIBRATION EXCITATION

(Also see Nos. 233, 234, 287, 288, 289, 312, 315, 329, 334)

80-365

Domains of Stability in a Wind-Induced Oscillation Problem

P.J. Holmes

Dept. of Theoretical and Appl. Mechanics, Cornell Univ., Ithaca, NY 14853, J. Appl. Mech., Trans. ASME, 46 (3), pp 672-676 (Sept 1979) 4 figs, 14 refs

Key Words: Vortex shedding, Fluid-induced excitation, Stability methods

In two earlier papers, the motion of a structure induced by vortex shedding was investigated for the cases of resonance and order three subharmonic resonance. In this paper it is shown that for light damping, the domain of stability has an extremely complex boundary due to the presence of heteroclinic orbits.

80-366

Parametrically Excited Nonlinear Multidegree-of-Freedom Systems

E.G. Tezak

Ph.D. Thesis, Virginia Polytechnic Inst. and State Univ., 166 pp (1979)

UM 7921033

Key Words: Multidegree of freedom systems, Parametric excitation, Modal damping, Flutter

An analysis of parametrically excited nonlinear multi-degree-of-freedom systems is presented. The nonlinearity considered is cubic and small so that the system of equations is weakly nonlinear. Modal damping is included and the parametric excitation is harmonic. The systems examined include those with distinct natural frequencies as well as those with a single repeated frequency. The significant role played by the existence of an internal resonance is explored in depth. The derivative-expansion version of the method of multiple scales, a perturbation technique, is used to develop solvability conditions for the various combinations of internal and parametric resonances considered.

80-367

On the Stick-Slip Phenomenon

F. Vatta

Istituto di Meccanica Applicata alle Macchine, Politecnico, Torino, Italy, Mech. Res. Comm., 6 (4), pp 203-208 (Apr 1979) 7 figs, 6 refs

Key Words: Stick-slip response

This article discusses stick-slip phenomenon in detail.

80-368

Analysis of Cyclic Simple Shear Test Data

C.K. Shen, L.R. Herrmann, and K. Sadigh

Dept. of Civil Engrg., University of California, Davis, CA, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 864-874, 8 figs, 4 tables, 8 refs

Key Words: Shear strength, Soils, Experimental data

Cyclic simple shear test data obtained from the Norwegian Geotechnical Institute (NGI) apparatus are examined and interpreted to better relate them to actual soil behavior. The study is made using a linear elastic finite element analysis. Available data for a medium dense sand, a soft clay and a chemically stabilized fine sand are analyzed.

MECHANICAL PROPERTIES

DAMPING

(Also see Nos. 313, 316, 332, 362, 363, 410, 413)

80-369

Damping in Saturated Soil

R.D. Stoll

Columbia Univ., New York, NY, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 960-973, 5 figs, 17 refs

Key Words: Soils, Viscous damping, Sound attenuation, Mathematical modulus

A mathematical model is described which predicts damping and wave velocity in water-saturated soils. Two mechanisms for energy loss are included in the model: one accounts for inelasticity of the soil skeleton in a water environment and the other for viscous losses in the pore-water as it moves relative to the skeleton. The model is an extension of the classical work of Biot and it has been used successfully to predict attenuation of acoustic waves in ocean sediments over a wide range of frequencies.

80-370

Dynamic Response of San Francisco Bay Mud

K.H. Stokoe, II and P.F. Lodde

Dept. of Civil Engrg., Univ. of Texas at Austin, TX, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 940-959, 11 figs, 1 table, 18 refs

Key Words: Soils, Shear modulus, Material damping, Resonant column method

Shear moduli and material damping of undisturbed samples of San Francisco Bay mud were investigated in the laboratory with the resonant column method. These properties were studied over a range in single-amplitude shearing strains from 0.0002 to 0.2 percent and over a range in confining pressures from 2.5 to 80 psi.

FATIGUE

(Also see Nos. 224, 344)

80-371

Relationships Between Low-Cycle Fatigue and Fatigue Crack Growth Rate Properties

L.R. Kaisand and D.F. Mowbray

Mechanical Technology Inc., 968 Albany-Shaker Rd., Latham, NY 12110, J. Test Eval. (ASTM), 7 (5), pp 270-280 (Sept 1979) 13 figs, 3 tables, 22 refs

Key Words: Fatigue tests, Crack propagation

A fracture mechanics model is developed to describe crack growth in a low cycle fatigue test specimen. The model involves an integral analysis and a growth rate hypothesis. A relationship for low cycle fatigue is derived that has strain energy density as the controlling variable. This relationship reduces to well-known low cycle fatigue equations in terms of elastic and plastic strains for the limiting conditions of fully elastic and fully plastic strain fields. These equations in turn define relationships between the material properties commonly employed to describe low cycle fatigue and fatigue crack growth rate data. The latter are used to demonstrate the facility of predicting fatigue crack growth rate curves from standard low cycle fatigue properties.

80-372

Probabilistic Fracture Mechanics

C.A. Rau, Jr. and P.M. Besuner

Failure Analysis Associates, Palo Alto, CA, Product Engr. (NY), 50 (10), pp 41-47 (Oct 1979) 15 figs

Key Words: Fatigue life

Basic concepts and new approaches which provide a quantitative means of assessing structural integrity and the risks and costs involved in continuing product use, repair or replacement are described.

ELASTICITY AND PLASTICITY

80-373

Damping of Punch Press Vibrations

L.L. Koss

Dept. of Mech. Engrg., Monash Univ., Wellington Rd., Clayton, Victoria, Australia 3168, Noise Control Engr., 13 (1), pp 5-12 (July/Aug 1979) 10 figs, 2 tables, 11 refs

Key Words: Vibration damping, Noise reduction, Urethane, Presses

A theoretical analysis and experimental results of the use of vibration damper material to suppress punch press vibrations and sound radiation are presented.

EXPERIMENTATION

MEASUREMENT AND ANALYSIS

(Also see Nos. 231, 282, 283, 370)

80-374

Horizontal Resonant Frequencies of Vibration Pickup on Soil Surfaces

S. Omata and S. Morita

College of Engrg., Nihon Univ., Tokusada, Koriyama, Fukushimaken 963, Japan, J. Acoust. Soc. Amer., 66 (4), pp 965-975 (Oct 1979) 14 figs, 13 refs

Key Words: Measuring instruments, Ground vibration, Vibration meters, Error analysis

This paper gives the characteristics of the horizontal resonant frequency and also derives expressions for a coupled motion of the vibration pickup model set on an elastic half-space. The derived solutions, which are approximately represented as the function of resonant frequency and the frequency of an exciting force, provide adequate accuracy for engineering analysis to the footings of little bodies.

80-375

Improving the Accuracy of Structural Response Measurements - Part II

J. O. Litz

Hewlett-Packard, Santa Clara Div., Santa Clara, CA, Test, 41 (5), pp 10-12 (Oct/Nov 1979) 2 figs

Key Words: Measuring instruments, Accelerometers, Error analysis

In the article a procedure for the identification and correction of mass loading and accelerometer loading errors is discussed.

80-376

Shock Pendulum Method for Calibrating and Testing Accelerometers (Stosspendelverfahren zum Kalibrieren und Prüfen von Beschleunigungsmessgeräten)

U. Wittkowski

Volkswagenwerk AG, Forschung und Entwicklung (Messtechnik), Postfach, 3180 Wolfsburg, Techn. Messen-ATM, 46 (9), pp 323-328 (Sept 1979) 10 figs, 1 table, 5 refs

(In German)

Key Words: Measuring instruments, Accelerometers, Calibrating

In order to calibrate and test accelerometers, accelerations of different amplitudes and with known spectra are necessary. The exact amplitude is measured by means of a standard instrument, while the bandwidth of the spectrum can be estimated with good approximation using the duration of the shock in connection with plain mathematical functions. The device can be used in an on-line measuring system and enables calibration and test with small loss time.

80-377

Wheel Torque Measuring Device for the Adjustment of Chassis Dynamometers Used in Exhaust Emission and Fuel Economy Tests (Rad-Drehmoment-Messeinrichtung zur Einstellung von Fahrzeug-Rollenprufstanden für Abgas- und Kraftstoffverbrauchstests)

W. Berg, K. Bohringer, and G. Keppler

Daimler-Benz Aktiengesellschaft, Postfach 202, 7000 Stuttgart 60, Techn. Messen-ATM, 46 (9), pp 329-338 (Sept 1979) 8 figs, 3 refs

(In German)

Key Words: Measuring instruments, Dynamometers, Wheels, Torque

A special device was developed which allows direct measurement of the force exerted from the driving wheels of a vehicle to the road and reproduction of this force - measured as torque - on a chassis dynamometer.

80-378

Computer Simulation of Tire Slip on a Clayton Twin Roll Dynamometer

J. Yurko

Standards Development and Support Branch, Environmental Protection Agency, Ann Arbor, MI, Rept. No. SDSB-79/10, 15 pp (Feb 1979)

PB-297 764/3GA

Key Words: Measuring instruments, Dynamometers, Computerized simulation

A computer simulation of tire slip on a Clayton twin roll dynamometer is studied.

80-379

A Pillar Dynamometer to Measure the Forces on Discs Cutting Through Rock

S.D. Drew, H.J. Hignett, P.E. Johnson, and G.I. Craff

Transport and Road Research Lab., Dept. of the Environment, Crowthorne, Berkshire, Instn. Mech. Engr. Proc., 193, pp 169-175 (June 1979) 13 figs, 2 tables, 5 refs

Key Words: Dynamometers, Tools, Cutting, Rocks

This paper describes the design, development and application of pillar dynamometers to measure the forces on discs cutting through rock both in field trials using full-face tunneling machines and in laboratory experiments.

80-380

Data Acquisition and Waveform Analysis

Diesel Gas Turbine Prog., 45 (9), pp 31-32 (Sept 1979) 3 figs

Key Words: Oscilloscopes, Data processing, Computer-aided techniques

Norlands Corporation 3001 processing digital oscilloscope for waveform analysis is described. It has full capabilities

when used to analyze parameters for diesel, gas, gasoline and gas turbine engines. Such parameters as work, burn rate, pressure, speed-torque, material expansion and contraction, eddy current crack or fracture analysis, etc., are just a few of the more commonly analyzed phenomenon.

80-381

On the Mechanism of Transduction in Optical Fiber Hydrophones

H.L. Price

Tracor, Inc., 1601 Research Blvd., Rockville, MD 20850, J. Acoust. Soc. Amer., 66 (4), pp 976-979 (Oct 1979) 1 fig, 1 table, 7 refs

Key Words: Measuring instruments, Acoustic measuring instruments, Hydrophones, Underwater sound

The receiving sensitivity of optical fiber hydrophones is determined in part by the rate of change in the optical path length of the sensing fiber with respect to changes in the external pressure on the fiber. These changes in the optical path length are a result of the induced changes in index of refraction of the fiber (photoelasticity) and changes in the physical length of the fiber (elasticity). These two properties are analyzed to determine their individual impacts on the hydrophone sensitivity.

80-382

A Unidirectional Acoustic Focusing Device with a Group of Three Electrodes

K. Toda

Dept. of Electrical Engrg., National Defense Academy, Hashirimizu, Yokosuka 239, Japan, J. Acoust. Soc. Amer., 66 (4), pp 980-982 (Oct 1979) 6 figs, 4 refs

Key Words: Measuring instruments, Acoustic measuring instruments, Transducers

A unidirectional device for acoustic focusing has been devised. The transducer consists of a group of three electrodes deposited on two surfaces of a thin piezoelectric ceramic plate. One of them is used as a common earth electrode and is on the substrate surface in contact with water. The others are interdigital electrodes on the other surface. The design and basic focusing properties of the device are described.

80-383

Variables Affecting in SITU Seismic Measurements

K.H. Stokoe, II and R.J. Hoar

Dept. of Civil Engrg., Univ. of Texas at Austin, TX, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 919-939, 12 figs, 1 table, 19 refs

Key Words: Measurement techniques, Measuring instruments, Seismic waves

Variables which can affect the accuracy of in situ measurements of compression and shear wave velocities by the crosshole and downhole seismic methods are discussed.

80-384

A Nearfield, Underwater Measurement System

R.D. Marciniak

Applied Research Lab., The Pennsylvania State Univ., University Park, PA 16802, J. Acoust. Soc. Amer., 66 (4), pp 955-964 (Oct 1979) 10 figs, 1 table, 23 refs

Key Words: Measurement techniques, Acoustic measurement, Underwater sound

A nearfield acoustic measurement technique for accurately computing the farfield radiation characteristics of underwater sound transducers is developed, implemented, and evaluated. The analysis is based on evaluation of a form of the Helmholtz integral which utilizes a Green's function. An experimental program was conducted to evaluate the technique. Details of the nearfield measurement instrumentation are presented. Comparisons between conventionally measured farfield properties of four different types of test transducers and the results obtained by using the nearfield technique are given.

DYNAMIC TESTS

(Also see Nos. 230, 238, 244, 285, 292, 318, 352, 368, 371)

80-385

Material Testing Under Dynamic Loads

J.J. Brun

SKF Clamart, Ball Bearing J., 200, pp 23-25 (Aug 1979) 4 figs

Key Words: Dynamic tests, Test equipment

SKF has developed a range of servo-controlled, hydraulic machines for dynamic testing. The machines are technically sophisticated, using for example, micro-processors.

80-386

A Sub-Seismic Test Platform as a Motion Exciter

B.J. Simmons

Frank J. Seiler Research Lab., U.S. Air Force Academy, CO, 14 pp (1979), presented at the Instrumentation Symp. of the Instrument Soc. of Amer. (25th), Anaheim, CA, May 7-10, 1979

AD-A069 848/0GA

Key Words: Test facilities, Vibrators (machinery)

The technique and use of a large pneumatically supported test platform as a motion exciter is described. Maximum motion capability, and the effects of system resonances of the 450,000 lb, servo controlled, isolation test platform is shown for use in tests of motion sensors (e.g., inertial navigation gyros and accelerometers, seismometers, and tiltmeters). The possibility of large test specimens, such as a complete navigation system, is considered.

80-387

Measuring Dynamic IN SITU Geotechnical Properties

J.L. Bratton and C.J. Higgins

Civil/Nuclear Systems Corp., Albuquerque, NM, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. I, pp 272-289, 12 figs, 1 table, 8 refs

Key Words: Soils, Dynamic tests, Testing techniques

A cylindrical dynamic in situ geotechnical material property test procedure is described. The test design and material property analysis are discussed. The analysis procedure involves iterating on the material properties use in one-dimensional and two-dimensional finite difference models of the test until the data measured in the experiment are reproduced. Typical results for several different soil types are presented and comparisons are made with laboratory measured material properties.

80-388

Random Vibration Screening of an Airborne Digital Computer

J.E. Anderson and H.C. Hurley

International Business Machines Corp., Federal Systems Div., Owego, NY, J. Environ. Sci., 22 (5), pp 25-26 (Sept/Oct 1979) 9 figs, 3 tables, 3 refs

Key Words: Airborne equipment response, Vibration tests, Random vibration

This paper describes the environmental testing being done on the F-15 airborne central digital computer. These tests are run after the initial functional checkout but before customer acceptance test. More than 400 computers have undergone at least 200 hours of environmental screen tests consisting of operation during temperature cycling, operation at high temperature, and operation at low temperature after a stabilization soak period.

80-389

Dynamic Response of a Sand Under Random Loadings

C.K. Shen, L.F. Harder, J.L. Vrymoed, and W.J. Bennett

Dept. of Civil Engrg., Univ. of California, Davis, CA, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 852-863, 7 figs, 5 tables, 14 refs

Key Words: Sand, Random excitation, Experimental data, Dynamic tests

This paper summarizes a laboratory investigation on undrained triaxial specimens of fine sand, compacted to different densities, subjected to random loading conditions. During the application of the random load, the pore water pressure and axial deformation developed were recorded. All tests were carried out with an electro-hydraulic closed-loop system using a magnetic tape data recorder to control the random load applied. Identical soil specimens were tested using four different random load-time traces.

80-390

Cyclic Shear Strength of Variably Cemented Sands

L.A. Salomone, H. Singh, and J.A. Fischer

Dames & Moore, Cranford, NJ, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical

Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 819-835, 10 figs, 4 refs

Key Words: Testing techniques, Sand, Shear strength

The purpose of the study is to evaluate the in situ physical state of the sands and relate these results to the dynamic properties which were obtained in the laboratory. The properties of the Vincentown Formation, a cemented silty fine to medium sand, was studied by means of field observations and laboratory triaxial CIUC tests and cyclic triaxial liquefaction tests. In addition, petrographic analyses of the Vincentown Formation was conducted to explore the mineralogy and physical properties of the sedimentation and to evaluate to what extent diagenetic processes have affected these initially unconsolidated Coastal Plain sediments.

80-391

Measurement of Dynamic Soil Properties

R.D. Woods

Dept. of Civil Engrg., Univ. of Michigan, Ann Arbor, MI, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. I, pp 91-180, 67 figs, 3 tables, 71 refs

Key Words: Soils, Dynamic tests, Reviews

Various aspects of dynamic soil testing presented in a number of state-of-the-art reviews, papers, and recent developments, are summarized.

SCALING AND MODELING

80-392

A Small Explosive Simulation of Earthquake-like Ground Motions

C.J. Higgins, K.B. Simmons, and S.F. Pickett

Eric H. Wang Civil Engrg. Research Facility, Univ. of New Mexico, Albuquerque, NM, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. I, pp 512-529, 14 figs, 7 refs

Key Words: Earthquakes, Simulation, Ground motion

A small experiment, named MINI-SIMQUAKE, was conducted to verify the technical feasibility of sequentially detonating closely spaced planar arrays of high explosives for the purpose of simulating earthquake-like ground motions. The experiment contained two explosive arrays which were detonated 0.3 sec apart. Ground motions and the response of a small cylindrical structure were measured with accelerometers and velocity gages. In addition, an angular displacement measurement was made in the structure.

80-393

Ground Motion Induced Interface Pressures

C.J. Higgins

Geotechnical Analysis Div., Eric H. Wang Civil Engrg. Research Facility, Univ. of New Mexico, Albuquerque, NM, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. I, pp 492-511, 13 figs, 5 tables, 4 refs

Key Words: Ground motion, Simulation, Interaction: soil-structure

Interface pressures on the sides and bases of embedded cylindrical structures were measured during two experiments in which strong ground shaking was generated with high explosives.

DIAGNOSTICS

80-394

Rolling Element Bearing Vibration Transfer Characteristics: Effect of Stiffness

M.F. While

Inst. of Sound and Vibration Res., The University, Southampton, UK, J. Appl. Mech., Trans. ASME, 46 (3), pp 677-684 (Sept 1979) 13 figs, 12 refs

Key Words: Diagnostic techniques, Rolling contact bearings, Stiffness coefficients, Frequency response method

Vibration transmission through rolling element bearings is investigated in order to aid signal interpretation for use in machinery condition monitoring studies. This relationship between bearing nonlinear stiffness and frequency response function is derived for bearings of types commonly used in rotating machinery. By considering the contact deformation of individual elements the stiffness characteristic for a

complete bearing is evaluated for the case c a radially applied load. Variation in stiffness of the complete bearing as elements moved through the load zone is calculated for bearings of a specified type and size. These values are also used to dynamically model typical rolling element bearing nonlinear behavior.

80-395

Data Presentation Techniques for Trend Analysis and Malfunction Diagnosis

R.C. Eisenmann

Mech. Engrg. Services, North American Region, Bently Nevada Corp., Houston, TX, Machinery Vibration Monitoring and Analysis Seminar, Proc., Feb 13-15, 1978, Houston, TX, 20 pp

Sponsored by the Vibration Inst., Clarendon Hills, IL

Key Words: Diagnostic techniques, Data presentation

Data presentation techniques for trend analysis and malfunction diagnosis are addressed in this paper. This review encompasses many of the contemporary formats utilized in the documentation of steady state and transient vibration data. The methods apply to a typical industrial transducer suite consisting of proximity displacement probes, velocity seismoprobes, and piezoelectric accelerometers.

80-396

Machinery Diagnostic Techniques and Systems. A State of the Art Survey

J.S. Mitchell

31882 Paseo Alto Plano, San Juan Capistrano, CA 92675, Machinery Vibration Monitoring and Analysis Seminar, Proc., Feb 13-15, 1978, Houston, TX, 13 pp

Sponsored by the Vibration Inst., Clarendon Hills, IL

Key Words: Diagnostic techniques, Machinery components, Reviews

In this paper currently available methods of measuring machinery condition are examined. An attempt is made to outline the strength and weaknesses of each method and look into the future to visualize where the field is headed.

BALANCING

80-397

Installation and Commissioning of New Equipment

C. Jackson

Monsanto Co., P.O. Box 1311 - MS0A16, Texas City, TX 77590, Machinery Vibration Monitoring and Analysis Seminar, Proc., Feb 13-15, 1978, Houston, TX, 12 pp

Sponsored by the Vibration Inst., Clarendon Hills, IL

Key Words: Design techniques, Equipment, Balancing techniques, Alignment

This paper concerns the installation and commissioning of new equipment used in the petrochemical industry. The design and operating premise of the equipment are considered. Commissioning and successful operation of machinery as the culmination of four years of active, premeditated, methodical preparatory practical engineering are described.

ANALYSIS AND DESIGN

ANALOGS AND ANALOG COMPUTATION

(Also see No. 328)

80-398

Energy-State Formulation of Lumped Volume Dynamic Equations with Application to a Simplified Free Piston Stirling Engine

C.J. Daniele and C.F. Lorenzo

NASA Lewis Research Ctr., Cleveland, OH, Rept. No. NASA-TM-79197; E-075, 30 pp (1979)

N79-27663

Key Words: Lagrange equations of motion, Equations of motion

Lumped volume dynamic equations are derived using an energy state formulation. This technique requires that kinetic and potential energy state functions be written for the physical system being investigated. To account for losses in the system, a Rayleigh dissipation function is formed. Using these functions, a Lagrangian is formed and using Lagrange's equation, the equations of motion for the system

are derived. The results of the application of this technique to a lumped volume are used to derive a model for the free piston Stirling engine. The model was simplified and programmed on an analog computer. Results are given comparing the model response with experimental data.

ANALYTICAL METHODS

(Also see Nos. 236, 240, 271, 321, 330, 353)

80-399

Flutter Analysis of Two-Dimensional and Two-Degree-of-Freedom Airfoils in Small Disturbance, Unsteady Transonic Flow

T.Y. Yang, A.G. Striz, and P. Guruswamy
School of Aeronautics and Astronautics, Purdue Univ., Lafayette, IN, Rept. No. AFFDL-TR-78-202, 116 pp (Dec 1978)
AD-A069 223/6GA

Key Words: Airfoils, Flutter, Computer programs

Flutter analyses are performed for a NACA 64A006 and a NACA 64A010 airfoil by simultaneously using two transonic aerodynamic computational codes: STRANS2 and UTRANS2 based on the relaxation method, and LTRAN2 based on the indicial and time-integration methods. The trend of each flutter curve and the effect of each parameter are discussed in detail.

80-400

Separation of Force-Time Function According to Their Origin (Trennung von Beanspruchungs - Zeit-Funktionen nach ihrem Ursprung)

O. Buxbaum and J.M. Zaschel
Fraunhofer-Institut f. Betriebsfestigkeit (LBF), Darmstadt, West Germany, Konstruktion, 31 (9), pp 345-351 (Sept 1979) 13 figs, 12 refs
(In German)

Key Words: Frequency analyzers, Stability

Time-dependent loads are generally recorded over a long period of time, and the force-time function obtained in this manner contains superimposed components from environmental effects and operating loads. For the evaluation of operating stability of a system, these components must be separated. According to the properties of the respective time functions of the total force, the separation may be accomplished either by frequency filtering or by digital vibration filtering. The methods are illustrated by means of examples.

80-401

Development and Evaluation of a Procedure for Simulating a Random Directional Second-Order Sea Surface and Associated Wave Forces

J.N. Sharma
Ph.D. Thesis, Univ. of Delaware, 155 pp (1979)
UM 7921839

Key Words: Water waves, Boundary value problems, Random excitation

The boundary value problem with the appropriate boundary conditions for the three dimensional nonlinear random wave field is reviewed. Using perturbation techniques, the nonlinear problem is converted into a series of linear boundary value problems. These are solved to the second order for the finite depth case in terms of finite Fourier sums, including relationships for the second order interaction components.

MODELING TECHNIQUES

(Also see Nos. 221, 225, 237, 262, 263, 265, 267, 284, 295, 301, 319, 322)

80-402

A Mathematical Model of Masonry for Predicting its Linear Seismic Response Characteristics

Y. Mengi and H.D. McNiven
Earthquake Engrg. Research Ctr., California Univ., Richmond, CA, Rept. No. UCB/EERC-79/04, NSF/RA-790069, 115 pp (Feb 1979)
PB-298 266/8GA

Key Words: Seismic response, Mathematical models, Masonry

This report is devoted to developing a mathematical model for masonry which could be used to derive the elastic stress field, in a wall or pier, when either is subjected to seismic loads.

NONLINEAR ANALYSIS

(Also see No. 320)

80-403

A Modified Stroboscopic Method for Non-Linear Vibration Equations

P.A.T. Christopher
College of Aeronautics, Cranfield Inst. of Tech., Bedford MK43 0AL, UK, J. Sound Vib., 66 (1), pp 91-97 (Sept 8, 1979) 1 fig, 8 refs

Key Words: Vibration response, Nonlinear theories

A technique is developed for determining approximate periodic solutions to a class of non-linear differential equations which often arise in vibration theory. The method is illustrated by application to a well known example and it is shown to give correct results.

NUMERICAL METHODS

80-404

Improved Extended Field Method Numerical Results

S. Chander, B.K. Donaldson, and H.M. Negm
Control Data Corp., Rockville, MD, J. Sound Vib., 66 (1), pp 39-51 (Sept 8, 1979) 2 figs, 3 tables, 17 refs

Key Words: Extended field method, Numerical analysis, Boundary value problems, Eigenvalue problems

This paper deals with an approximate method of analysis for boundary value problems called the extended field method. The purpose of this paper is to present a series of numerical results which primarily supersede all previously reported unsatisfactory numerical results and secondarily extend the geometric range of application. The extended field method can now, for all types of harmonically vibrating, uniform, thin plates, produce deflection amplitude numerical solutions of unsurpassed convergence.

80-405

Numerical Methods for Extremely Stiff Systems of Ordinary Differential Equations

T.D. Bui and T.R. Bui
Dept. of Computer Science, Sir George Williams Campus, Concordia Univ., Montreal, Quebec, Canada, Appl. Math. Modeling, 3 (5), pp 355-358 (Oct 1979) 15 refs

Key Words: Numerical analysis, Dynamic systems, Runge-Kutta method, Computerized simulation

New techniques for solving extremely stiff systems of differential equations are proposed in this paper. These algorithms are based on a class of implicit Runge-Kutta procedure with complete error estimate. The new techniques are applied to solving mathematical models of the relaxation problem behind blast waves.

STATISTICAL METHODS

(Also see No. 286)

80-406

A Unified Study of the Multivariate Joint Probability Function of the State Variables with Quantized Levels for a Stochastic Environmental System with Discrete Data: Theory and Experiment

M. Ohta, K. Hatakeyama, and M. Nishimura
Cluster II Electrical and Industrial Engrg., Hiroshima Univ., Hiroshima City, Japan, J. Sound Vib., 66 (1), pp 75-89 (Sept 8, 1979) 5 figs, 6 refs

Key Words: Statistical analysis, Stochastic processes, Random excitation, Traffic noise

Theoretical consideration is given to the joint probability function with quantized levels and its joint factorial moments, which are suited to an actual situation where real experimental data are taken in quantized form: i.e., as finite sets of discrete numbers. As a special case when the level width tends to 0, the above theory includes the well-known expansion series distribution in continuous form. The validity of the theory is confirmed both by means of digital simulation and by application to experimentally observed road traffic noise and environmental noise data.

80-407

Reliability of Seismic Resistance Predictions

R.F. Drenick and C. Yun
Polytechnic Inst. of New York, Brooklyn, NY, ASCE J. Struc. Div., 105 (ST10), pp 1879-1891 (Oct 1979) 3 figs, 2 tables, 17 refs

Key Words: Statistical analysis, Damage prediction, Earthquake resistant structures

This paper explores the effect of uncertainties in the information regarding the ground-motion statistics during an earthquake. The paper also reports on a study in which the combination of probabilistic and worst-case analyses was explored.

PARAMETER IDENTIFICATION

(Also see Nos. 247, 268)

80-408

Damage Assessment and Reliability Evaluation of Existing Structures

J.T.P. Yao

School of Civil Engrg., Purdue Univ., West Lafayette, IN 47907, Engrg. Struc., 1 (5), pp 245-251 (Oct 1979) 7 figs, 78 refs

Key Words: System identification technique

In this paper, the concept of structural identification is examined. Several possible approaches making use of full-scale dynamic test data are reviewed and discussed.

80-409

Cyclic Loading of Sands, Silts and Clays

D.A. Sangrey, G. Castro, S.J. Poulos, and J.W. France

Cornell Univ., Ithaca, NY, Earthquake Engrg. and Soil Dynamics, Proc. of the ASCE Geotechnical Engrg. Div. Specialty Conf., Pasadena, CA (June 19-21, 1978), Vol. II, pp 836-851, 9 figs, 24 refs

Key Words: Soils, Mathematical models

The purpose of this paper is to illustrate that the response of saturated soils (sands, silts and clays) to cyclic loading may be describable with one behavioral model. The behavioral model is based on critical void ratio and critical state concepts - i.e., the use of void ratio and effective stresses as key parameters to define the state of the soil and therefore its response to cyclic loading. Test results from a variety of natural sands, silts and clays are used to illustrate the behavioral model.

COMPUTER PROGRAMS

(See Nos. 217, 218, 278, 333, 339)

CONFERENCE PROCEEDINGS AND GENERAL TOPICS

CONFERENCE PROCEEDINGS

80-410

Conference on Aerospace Polymeric Viscoelastic Damping Technology for the 1980's

L. Rogers

AFFDL/FBA, Wright-Patterson AFB, OH, Rept. No. AFFDL-TM-78-78-FBA, 575 pp (July 1978)

Key Words: Viscoelastic damping, Proceedings

At this conference, 25 state-of-the-art papers on the applications of viscoelastic damping were presented and further developments were discussed.

TUTORIALS AND REVIEWS

(Also see Nos. 391, 396)

80-411

Optimization Techniques for Shock and Vibration Isolator Development

R.W. Mayne

Mech. Engrg. Dept., SUNY at Buffalo, NY, Shock Vib. Dig., 11 (10), pp 25-33 (Oct 1979) 1 fig, 40 refs

Key Words: Reviews, Isolators, Vibration isolators, Shock absorbers, Optimization, Nonlinear programming, Time domain method, Frequency domain method

The purpose of this effort is to summarize work that has been published on optimization methods with application

to shock and vibration isolation since 1976. The article is divided into three sections: the first deals with nonlinear programming methods that are basic tools for engineering optimization problems of all types; the second is concerned with time domain methods of isolator optimization as evolved from optimal control theory; and the third focuses on those cases where isolation systems are considered in the frequency domain.

80-412

Recent Research in Composite and Sandwich Plate Dynamics

C.W. Bert
School of Aerospace, Mechanical and Nuclear Engrg., Univ. of Oklahoma, Norman, OK, Shock Vib. Dig., 11 (10), pp 13-23 (Oct 1979) 1 table, 95 refs

Key Words: Reviews, Plates, Sandwich structures, Composite structures

This paper surveys literature concerning dynamics of plate-type structural elements of either composite material or sandwich construction. Papers from 1976 through early 1979 are reviewed. Special attention is given to rectangularly orthotropic, cylindrically orthotropic, and anisotropic plates; laminated plates; thick and sandwich plates; and nonlinearities. Free vibration, harmonic and random forced vibration, thermally and flow induced vibration (flutter), and impact are also treated.

80-413

Dynamic Mechanical Properties of Fiber-Reinforced Composite Materials

R.F. Gibson and D.G. Wilson
Dept. of Engrg. Science, Univ. of Idaho, Moscow, ID 83843, Shock Vib. Dig., 11 (10), pp 3-11 (Oct 1979) 83 refs

Key Words: Reviews, Fiber composites, Internal damping, Dynamic stiffness

This paper reviews recent efforts to characterize the internal damping and dynamic stiffness of fiber-reinforced composite materials under vibratory loading. Several trends are noted, and suggestions are offered regarding directions of future research.

CRITERIA, STANDARDS, AND SPECIFICATIONS

(See No. 350)

AUTHOR INDEX

CALENDAR

FEBRUARY 1980

3-7 Energy Technology Conference and Exhibition [ASME] New Orleans, LA *(ASME Hq.)*

19 Current Techniques in Vibration Measurement and Recording [SEE] London, England *(SEE Hq.)*

26-29 Congress & Exposition [SAE] Cobo Hall, Detroit, MI *(SAE Meeting Dept.)*

MARCH 1980

9-13 25th Annual International Gas Turbine Conference and Exhibit [ASME] New Orleans, LA *(ASME Hq.)*

24-27 Design Engineering Conference and Show [ASME] McCormick Place, Chicago, IL *(ASME Hq.)*

APRIL 1980

21-25 Acoustical Society of America, Spring Meeting [ASA] Atlanta, GA *(ASA Hq.)*

28-May 1 NOISEXPO '80 [S/V, Sound and Vibration] Hyatt Regency O'Hare, Chicago, IL *(Acoustic Publications, Inc., 27101 E. Oviat Rd., Bay Village, OH 44140)*

MAY 1980

5-8 Offshore Technology Conference, Astrohall, Houston, TX *(ASME Hq.)*

11-14 1980 Annual Technical Meeting & Equipment Exposition [IES] Philadelphia, PA *(IES Hq.)*

19-23 Fourth International Conference on Pressure Vessel Technology [ASME] London, England *(ASME Hq.)*

25-30 Fourth SESA International Congress on Experimental Mechanics [SESA] The Copley Plaza, Boston, MA *(SESA Hq.)*

JUNE 1980

11 Experimental Techniques for Fatigue Crack Growth Measurement [SEE] British Rail Technical Centre *(SEE Hq.)*

22-26 Summer Annual Meeting [ASME] Waldorf-Astoria, New York, NY *(ASME Hq.)*

JULY 1980

7-11 Recent Advances in Structural Dynamics Symp., [Institute of Sound and Vibration Research] University of Southampton, Southampton, S09 5NH, UK *(Mrs. O.G. Hyde, ISVR Conference Secretary, The University, Southampton, S09 5NH, UK - Tel (0703) 559122, Ext 2310)*

SEPTEMBER 1980

2-4 International Conference on Vibrations in Rotating Machinery [IMechE] Cambridge, England *(Mr. A.J. Tugwell, Institution of Mechanical Engineers, 1 Birdcage Walk, London SW1H 9JJ, UK)*

8-11 Off-Highway Meeting and Exposition [SAE] MECCA, Milwaukee, WI *(SAE Hq.)*

OCTOBER 1980

Stapp Car Crash Conference [SAE] Detroit, MI *(SAE Hq.)*

Joint Lubrication Conference [ASME] Washington, D.C. *(ASME Hq.)*

6-8 Computational Methods in Nonlinear Structural and Solid Mechanics [George Washington University & NASA Langley Research Center] Washington, D.C. *(Professor A.K. Noor, The George Washington University, NASA Langley Research Center, MS246, Hampton, VA 23665- Tel (804)827-2897)*

21-23 51st Shock and Vibration Symposium [Shock and Vibration Information Center, Washington, D.C.] San Diego, CA *(Henry C. Pusey, Director, SVIC, Naval Research Lab., Code 8404, Washington, D.C. 20375)*

NOVEMBER 1980

18-21 Acoustical Society of America, Fall Meeting [ASA] Los Angeles, CA *(ASA Hq.)*

DECEMBER 1980

Aerospace Meeting [SAE] San Diego, CA *(SAE Hq.)*

CALENDAR ACRONYM DEFINITIONS AND ADDRESSES OF SOCIETY HEADQUARTERS

AFIPS: American Federation of Information Processing Societies
210 Summit Ave., Montvale, NJ 07645

AGMA: American Gear Manufacturers Association
1330 Mass. Ave., N.W.
Washington, D.C.

AHS: American Helicopter Society
1325 18 St. N.W.
Washington, D.C. 20036

AIAA: American Institute of Aeronautics and Astronautics, 1290 Sixth Ave.
New York, NY 10019

AIChE: American Institute of Chemical Engineers
345 E. 47th St.
New York, NY 10017

AREA: American Railway Engineering Association
59 E. Van Buren St.
Chicago, IL 60605

ARPA: Advanced Research Projects Agency

ASA: Acoustical Society of America
335 E. 45th St.
New York, NY 10017

ASCE: American Society of Civil Engineers
345 E. 45th St.
New York, NY 10017

ASME: American Society of Mechanical Engineers
345 E. 45th St.
New York, NY 10017

ASNT: American Society for Nondestructive Testing
914 Chicago Ave.
Evanston, IL 60202

ASQC: American Society for Quality Control
161 W. Wisconsin Ave.
Milwaukee, WI 53203

ASTM: American Society for Testing and Materials
1916 Race St.
Philadelphia, PA 19103

CCCAM: Chairman, c/o Dept. ME, Univ. Toronto,
Toronto 5, Ontario, Canada

ICF: International Congress on Fracture
Tohoku Univ.
Sendai, Japan

IEEE: Institute of Electrical and Electronics Engineers
345 E. 47th St.
New York, NY 10017

IES: Institute of Environmental Sciences
940 E. Northwest Highway
Mt. Prospect, IL 60056

IFToMM: International Federation for Theory of Machines and Mechanisms
U.S. Council for TMM
c/o Univ. Mass., Dept. ME
Amherst, MA 01002

INCE: Institute of Noise Control Engineering
P.O. Box 3206, Arlington Branch
Poughkeepsie, NY 12603

ISA: Instrument Society of America
400 Stanwix St.
Pittsburgh, PA 15222

ONR: Office of Naval Research
Code 40084, Dept. Navy
Arlington, VA 22217

SAE: Society of Automotive Engineers
400 Commonwealth Drive
Warrendale, PA 15096

SEE: Society of Environmental Engineers
6 Conduit St.
London W1R 9TG, UK

SESA: Society for Experimental Stress Analysis
21 Bridge Sq.
Westport, CT 06880

SNAME: Society of Naval Architects and Marine Engineers
74 Trinity Pl.
New York, NY 10006

SPE: Society of Petroleum Engineers
6200 N. Central Expressway
Dallas, TX 75206

SVIC: Shock and Vibration Information Center
Naval Research Lab., Code 8404
Washington, D.C. 20375

URSI-USNC: International Union of Radio Science - U.S. National Committee
c/o MIT Lincoln Lab.
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